ONTARIO

REPORT OF THE

Royal Commission on the use of Radium and X-Rays in the Treatment of the Sick, Etc.

PRINTED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed and Published by Herbert H. Ball, Printer to the King's Most Excellent Majesty
1932

ONTARIO

REPORT OF THE
Royal Commission on the use of Radium and X-Rays in the Treatment of the Sick, Etc.

PRINTED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO
SESSIONAL PAPER No. 41, 1932

COMMISSION

HENRY JOHN CODY, *Chairman*
JOHN CUNNINGHAM MCLENNAN
WALTER THOMAS CONNELL
ARTHUR R. FORD

Secretary
JOHN W. S. MCCULLOUGH

TORONTO
Printed and Published by Herbert H. Ball, Printer to the King's Most Excellent Majesty
1932

To the Right Honourable The Administrator of the Government:

SIR:

Under authority of the attached Order-in-Council, dated the 29th day of May, 1931, the undersigned were appointed a Royal Commission to enquire into and report upon the use of radium and X-rays in the treatment of the sick, etc.

Your Commission begs to report as set forth in the following pages:

Copy of an Order-in-Council, approved by The Honourable the Lieutenant-Governor, dated the 29th day of May, A.D. 1931.

Upon the recommendation of the Honourable the Prime Minister, the Committee of Council advise that pursuant to the provisions of *The Public Enquiries Act*, Chapter 20, R.S.O. 1927, a Commission be issued under the Great Seal appointing the Honourable Dr. Henry John Cody, of the City of Toronto; Professor John Cunningham McLennan, of the City of Toronto; Dr. Walter Thomas Connell, of the City of Kingston, and Mr. Arthur Ford, of the City of London, to enquire into and report upon:

1. The use of Radium and X-rays for the treatment of the sick;
2. The advisability of the Province securing a supply of Radium for the above purpose;
3. The advisability of the Province establishing a radium emanation plant with the necessary laboratories, etc.
4. The advisability of establishing a cancer research department;
5. The advisability of establishing a cancer institute;
6. The advisability of establishing cancer clinics;
7. The advisability of adopting plans and methods for educating the public with respect to the prevention of cancer;
8. And generally any matter or question arising out of the subjects referred to the Commission, and which in the judgment of the Commission calls for investigation and consideration.

The Committee further advise that the said Honourable Dr. Cody be appointed Chairman of said Commission.

And the Committee further advise that the Commission contain provision conferring power upon the Commissioners of summoning any person and requiring him to give evidence on oath and to produce such documents and things as the Commissioners may require for the full investigation of the matters into which they are appointed to examine.

Certified,

CONTENTS

CONTENTS

CONTENTS

INTRODUCTION

Your Commission was organized early in June, 1931, and pursued its enquiry as directed by Order-in-Council, first in Ontario, then in the United States, in the British Isles, and in European countries. Subsequently further investigation was made in the United States and in other parts of Canada. Finally there were meetings with medical bodies and individual medical men at various points in Ontario.

Because departmental control of both the prevention and the cure of disease is under the Department of Health, the Minister of Health, Hon. J. M. Robb, M.D., accompanied the Commission, and Dr. J. W. S. McCullough, Chief Inspector of Health, acted as Secretary.

While the studies of the Commission were largely directed to observing the curative effects of radium and of the diagnostic and curative capabilities of X-rays, opportunity was taken to enquire into all sides of the problem of cancer control in the countries visited.

In comparing the work of cancer control, organization and treatment in Ontario with that carried on elsewhere, it soon became apparent to the Commission that while the clinical results in our own Province were excellent and quite equal to those found elsewhere, the facilities for such work outside surgery were quite inadequate. While the largest hospital in Ontario has but two high-voltage X-ray machines and less than half a gramme of radium (in 1931 the Toronto General Hospital added half a gramme) some clinics seen by the Commission in the United States, the British Isles, and in Europe have eight or more grammes of radium and from six to eight high-voltage X-ray machines. It is obvious that in order satisfactorily to meet our situation in Ontario larger and better facilities for radio-therapy must be provided.

In most of the countries visited there were found centres for cancer treatment with well-equipped staffs of pathologists, radiologists, physicists, physicians and surgeons, all trained to collaborate. Ample opportunity also was provided for the education of trained personnel and of medical students.

The story of delay in seeking advice for cancerous conditions on the part of the masses of the people was constantly impressed upon the Commission at every stage of its investigation. Everywhere were found attempts to meet this situation by organized campaigns of public education and by the better training of medical students and of those proposing to specialize in this branch of medical science.

The necessity of following up cases was similarly emphasized. In every clinic an elaborate record of cases is kept. The utmost pains are taken to keep in touch with patients and to bring them back to the place of treatment for observation at regular intervals over a period of years until all possibility of the return of the disease is past. Since prevention is as needful in the case of cancer as it is in the case of other diseases, the preventive side is on all hands receiving the closest attention.

INTRODUCTION

As your Commission proceeded with its enquiry it felt increasingly the importance and urgency of the work on which it was engaged. During the last century medicine has won signal victories over many diseases. An analysis of these successes reveals that, until recently, most of them were connected with disorders directly attributable to parasitic micro-organisms. It is to the prevention of germ-caused diseases that the fall in our deathrate is chiefly due. But, as has been aptly said, "of all the maladies which continue to defy aetiological explanation and consequently, effective therapy, cancer is probably the most important, as it is certainly the most puzzling." If no remedy is found for it and the toll of death it levies on mankind is not reduced, at least one in ten of the adults now alive will sooner or later fall victims to it. It is no respecter of persons, yet those who have devoted their lives to its study are not yet agreed as to its actual cause. Never has the problem of the nature and cause of cancer been more widely and scientifically attacked than to-day. The surgeon and the radiologist are collaborating with increasing success in its treatment; and throughout the whole world of cancer research there blows a new air of hope and expectancy.

While it is impossible in a report of this nature to express the Commission's thanks to the many individual authorities to whom it is indebted for an enormous amount of information and literature, it may be sufficient to say that the members of the Commission met everywhere with unvarying courtesy and the utmost desire to facilitate their enquiry.

In the United States, Great Britain, France, Belgium, Germany, Sweden and Denmark, as well as in our own country, the local authorities afforded every opportunity to study the work in cancer in which they were engaged.

With great pleasure the Commission records these facts, and expresses its deep sense of obligation to those who thus aided in lightening its labours and in bringing within its reach all the information available on the subject.

Notable assistance was given to the Commission by the Hon. G. Howard Ferguson, Canadian High Commissioner, London; the Hon. Philippe Roy, Canadian Minister to France, Paris; Mr. Wm. C. Noxon, Agent-General for Ontario, London; M. J. J. Guay, Canadian Trade Commissioner, Brussels; Dr. C. N. Arpin, representative of the Dominion Department of Health, Antwerp; Prof. Errol Boucher, Paris; Mr. W. H. Ingram, the well-known journalist, Paris, and by Capt. F. A. Stewart, Agent for Ontario in Glasgow.

Your Commission gladly records its appreciation of the faithful and highly efficient service rendered by the Secretary, Dr. J. W. S. McCullough, Chief Inspector of Health for the Province. By his long experience of the problems of public health, by his careful study of the literature on the whole subject of cancer, by his wide correspondence with experts in this field, by his collection of material, and by his careful arrangements for the investigations made in different countries, he has given signal help to the Commission at every stage of its work. His services were placed at the disposal of the Commission by the Provincial Department of Health.

CHAPTER ONE

INVESTIGATIONS OF THE USES OF RADIUM AND X-RAYS IN TREATMENT OF THE SICK, AND ORGANIZATION FOR CANCER CONTROL

Section I

INVESTIGATIONS IN CANADA

CANADA

Investigations in the Provinces of Ontario and Quebec

Ontario, Canada

Radiological treatment of cancer in Ontario is confined to a few hospitals but is supplemented by the use of radium and X-rays in the hands of private practitioners.

The Toronto General Hospital

The most important organization in Ontario for radio-therapeutic treatment is that of the Toronto General Hospital, under the directorship of Dr. G. E. Richards.

The X-ray therapy department was organized in 1918. At this time, X-ray therapy generally was limited to apparatus capable of operating at a maximum of 100,000 volts and this was the type of apparatus then installed.

In 1919, a machine was assembled capable of delivering 120,000 volts, and with this favourable results were obtained sufficient to convince the director of the value of the so-called high voltage method.

In 1920 special apparatus was purchased for the purpose of more accurate measurements of X-ray dosages. This apparatus included (1) a spectrometer measuring the wave length of X-rays; and (2) a quadrant quadrimeter, in reality an electroscope, making use of the ionization chamber method of X-ray measurement.

In 1921 a suitable equipment became available in America and the first high-voltage machine was then installed in this department. This was capable of delivering 200,000 volts. During the next year a second machine was installed having a maximum capacity of 300,000 volts, although this has never been operated at a higher voltage than 250,000 and the usual operation is at 210,000.

The first radium was purchased in 1921, and since that time has been added to year by year as the work has grown, until at the present time the Department has a total of about 900 milligrammes of radium in the form of element. Radium emanation is not used.

The daily attendance in the radiological service averages 190 patients throughout the year, thirty being cancer cases for therapy, or reporting for observation. This does not include cancer cases in the wards of the hospital in the respective services.

The radium work in the department has generally followed the European, particularly the French School, rather than the American School, probably owing to the fact that the practice of the former was believed to be based on sounder work and attended by better results and partly to the fact that the personnel was limited to the use of radium applicators containing the element and did not have access to radium emanation except by purchase at prices almost prohibitive.

In 1928 recommendation was made that plans be prepared for an enlarged radiological service. This included the purchase of an additional gramme of radium, an emanation plant, a more powerful X-ray apparatus for therapy, and centralization of cancer patients who were receiving radium treatment in special beds set aside for the purpose.

These plans were approved by the members of the hospital staff and accepted by the trustees of the hospital, and it was planned to proceed with them early in the fall of 1930. For this purpose the building formerly occupied by the department of pathology in the University of Toronto was purchased from the University by the trustees of the hospital and set aside by an arrangement which would provide approximately fifty beds for this service.

From the very inception of this work no suitable case has ever been refused treatment because of the patient's inability to pay for the service.

The following statistics indicate the growth of the department and of its activities:

NUMBER OF RADIUM CASES TREATED SHOWING PERCENTAGE OF FREE TREATMENTS

	Total Number of Cases	Pay	Free	Percentage of Free Cases
October 1st, 1921 to September 30th, 1922	494	368	127	25.65
October 1st, 1922 to September 30th, 1923	670	509	161	24.03
October 1st, 1923 to September 30th, 1924	758	570	188	24.80
October 1st, 1924 to September 30th, 1925	828	408	220	26.57
October 1st, 1925 to September 30th, 1926	915	675	240	28.23
October 1st, 1926 to September 30th, 1927	896	603	293	32.70
October 1st, 1927 to September 30th, 1928	965	709	256	26.53
October 1st, 1928 to September 30th, 1929	845	561	284	33.61
October 1st, 1929 to September 30th, 1930	1,203	897	306	25.44
October 1st, 1930 to September 30th, 1931	1,321	913	408	30.88

NUMBER OF HIGH VOLTAGE X-RAY CASES SHOWING PERCENTAGE OF FREE TREATMENTS

	Total Number of Cases	Pay	Free	Percentage of Free Cases
October 1st, 1921 to September 30th, 1922	553	426	107	19.35
October 1st, 1922 to September 30th, 1923	626	475	151	24.12
October 1st, 1923 to September 30th, 1924	615	479	136	22.11
October 1st, 1924 to September 30th, 1925	690	512	178	25.79
October 1st, 1925 to September 30th, 1926	587	474	113	19.25
October 1st, 1926 to September 30th, 1927	665	491	174	26.17
October 1st, 1927 to September 30th, 1928	716	513	203	28.35
October 1st, 1928 to September 30th, 1929	897	697	200	22.30
October 1st, 1929 to September 30th, 1930	702	531	171	24.36
October 1st, 1930 to September 30th, 1931	897	658	239	26.65

The records, of the standard League of Nation's type, are well kept, and endeavour is made to maintain an effective social service. The director is of the opinion that if provision were made for the free transportation of poor patients, there would be a decided improvement in the final results of treatment.

General Conferences

At conferences held in Kingston, London and Toronto opportunity was given for the expression of opinion before the Commission by the representatives of medical bodies, individual practitioners and others; and other conferences

were held in Ottawa, Peterborough, etc., with individual practitioners or groups of clinicians.

Kingston

The *Kingston* General Hospital has no radium, but ninety milligrammes owned by the Dean of the Medical Faculty are always available for use. The X-ray plant comprises one 140-kv. machine and three for diagnosis. There are eleven beds available for cancer cases.

Dean Etherington of the Medical Faculty in his remarks emphasized the need of (1) better education of the medical practitioner; (2) close follow-up of cases; (3) close oversight of surgical work done in hospitals with a view to improvement.

Dr. James Miller, the Professor of Pathology, spoke of the possible value of the use of glandular extracts in cancer and of the necessity of securing more reliable statistics. He praised the systematic free examination of pathological growths maintained by the Department of Health.

Dr. J. Wylie, the Professor of Preventive Medicine, made a plea for the establishment in Kingston of a Cancer Research Institute, to comprise division of treatment, diagnosis, experimental research and statistics. He also suggested a survey radiating from Kingston in order to ascertain the incidence of cancer and the results of treatment, etc.

Dr. W. A. Jones, the Director of the Radiological Department, presented a statement of the physical requirements of the hospital for effective radiological treatment.

London

At the *Radiological* clinic in London, radium is used by the high intensity short-period method. There is a cancer committee comprising the chiefs of surgery, gynaecology, pathology, and radiology, of which Dr. George McNeill is chairman, who decide the line of treatment in important cases. Radio-therapy is in the hands of Drs. George McNeill and Ernest Williams.

It was suggested that education in respect to cancer is much needed by both the medical profession and the public; the latter should be instructed in simple methods of prevention.

Dr. Moir of Hensall advocated the establishment of twelve clinics for diagnosis and treatment in Ontario; he thought it a hardship for patients to travel great distances for treatment; he also advocated the appointment of a travelling radiologist for the purpose of co-ordinating cancer work in the centres.

Dr. McCrae of Brussels advocated the organization of local clinics near the people's homes; he thought people were afraid to go to the large city clinics.

Dr. David Arnott appeared as the advocate of the use of Koch's serum which he employs in the treatment of cancer.

At the Institute of Public Health, which is one of the chain of Ontario Public Health Laboratories, a most interesting piece of research work on cancer by Drs. Campbell and Johns is under way. At the moment the developments are not complete enough for publication.

Toronto

At the Toronto conference, representatives of the Academy of Medicine, the Canadian and Ontario Medical Associations, the University Faculty of Medicine, as well as many practitioners not only from Toronto but also from Hamilton, Brantford and other places, were heard. In addition, a few private

individuals expressed their views. While there was considerable diversity of opinion in respect to the character, designation, location and scope of the proposed organization for treatment by radio-therapy, all were agreed as to the need of research in respect to cancer, of skilled personnel in its treatment, and of better education for both doctors and the public.

Perhaps as significant a statement as any was that made by Dr. L. J. Austin, President of the Ontario Medical Association, who said that medical men in Ontario who have an opinion on the subject of radio-therapy may be divided into three groups:

1. Those who say that patients are made much worse by the use of radium and X-rays. In his opinion this view is not to be taken very seriously.
2. Those who advocate active-treatment clinics in each of the three university centres, the staff to be appointed by the respective universities.
3. Those who say that every city of 20,000 or over should have its own cancer treatment clinic. These, in his opinion, represent a large majority of the profession.

The President thought that a very intensive training in radiology is necessary, and, personally, is absolutely in favour of a limited number of centres.

As it is impossible in the space available in this report to give the complete addresses of the speakers at the conference it may suffice to quote some of the most salient remarks of each speaker.

Dr. Oskar Klotz, Professor of Pathology, University of Toronto, said: "Control of cancer depends upon co-operation of the laboratory and the doctor—the Government would be well advised to spend money on research; close association of cancer treatment with the University and Medical Faculty is essential."

Dr. George Wilson, Surgeon-in-Chief, St. Michael's Hospital: Had no objection to the name "Cancer Institute." He thought there should be active treatment centres in Toronto, London, and Kingston, controlled by the Government, provided with a first-class staff of whole-time men, and including facilities for research. The head of the "Institute" should preferably be an "Internist."

Dr. George Young, speaking for the Academy of Medicine: Would call the treatment centre a "Radio-therapeutic Institute" which should be in a separate building with its own staff, and closely linked up with the Physics Department. The Institute (in Toronto) should be used for diagnosis, treatment, research and for the supplying of radium to other approved centres.

The views of Dr. Harris McPhedran, President of the Academy of Medicine, coincided very largely with those of the previous speaker. Like the latter, he emphasized the value of improved professional training and public health education and close co-operation of all services in the interest of the patient.

Dr. Alexander Primrose, Dean of the Faculty of Medicine, agreed with Dr. Klotz in respect to the need for research and skilful diagnosis, but he was very strongly of the opinion that no diseases except infectious ones should be segregated. He thought that a cancer institute should be a part of a general hospital. In his opinion the interest of the patient was supreme; no single service or individual should dominate. Co-operation of the entire group was essential in the successful treatment of cancer.

Dr. T. C. Routley, the Secretary of the Ontario and Canadian Medical Associations, enquired why cancer or other disease should be set apart for treatment in separate instituiuons. "Are we," he asked, "to have a separate hospital or institute for each disease? Plants such as general hospitals with

laboratories exist in Ontario, why should these be duplicated at great expense?" He opposed a separate cancer institute to be managed by the Government and advocated the use of existing hospitals.

Drs. Clarkson, Harrison and Gillam, representatives of the Radium Institute, Toronto, emphasized the need of early diagnosis, of adequate training of personnel in radiology, and expressed satisfaction with the proposal of the organization of a cancer institute by the Government.

Dr. E. S. Hicks and other representatives of a group clinic in Brantford detailed their equipment, and gave statistics of their fifteen years' work in radiology. They had no objection to the organization of a cancer institute, and would welcome the establishment of an emanation plant from which radon (seeds) would be supplied to reliable radiologists.

Drs. Langrill, Deadman, Walkey, and Bethune, representing the Hamilton General Hospital, were of the opinion that most of the Government money available should be spent on research, that an emanation plant should be established, and that cancer clinics should be associated with approved general hospitals.

Dr. Herbert A. Bruce favoured the organization of one central institute for the main activities of cancer work in Toronto, with radium and an emanation plant, research laboratories, physical and pathological laboratories, and facilities for treatment by surgery and radiology. There should be a Radium Trust, responsible for funds, purchase of radium, etc., and a Radium Commission to decide what institutions should be given radium. He advocated many diagnostic clinics and a limited number of treatment centres. He was of the opinion that a cancer institute should be an entity by itself. He favoured research and thought the institution should be called a Hospital for Diagnosis and Treatment of Malignant and Other Diseases, and have about fifty beds for cancer patients. Dr. Bruce referred to the offer formerly made by him of the Wellesley Hospital for the purpose of a cancer institute. This offer, because of strong objections raised by the friends of the hospital, had been withdrawn.

Dr. Frederick W. Marlow advocated the organization of a Central Institute which might be called Ontario Research Hospital, with research laboratories, provision for 100 beds, and facilities for diagnosis and treatment of cancer. The functions of such institute should in his opinion, be research, post-graduate work, diagnosis and treatment. It should not be established in connection with any existing hospital and should receive public ward patients only. He saw no objection to such an institute in a wing of a large hospital, but it should be a separate unit and independent of the university.

Dr. G. E. Richards, the Director of Radiology, Toronto General Hospital, believed that the surgical treatment provided in Ontario was quite as good as that found elsewhere. He pointed out the need of better equipment in X-rays and radium. He advocated a cancer clinic in a general hospital, citing that of the Philadelphia General Hospital as a successful example. He was opposed to the development of too many treatment centres, and pointed out that Great Britain (with twelve outside London) had too many. He was favourable to research but thought that skilful diagnosis and treatment should be the chief objects. He believed that fifty beds were sufficient in a Toronto clinic, since of the 1,800 cases of cancer treated in the Toronto General Hospital last year, only one-third were hospitalized. Dr. Richards suggested the name "Radio-therapeutic Centre" or "Radiological Institute."

Dr. Gordon Bates, the Secretary of the Canadian Social Hygiene Council, laid stress upon the value of public education in cancer. He advocated a policy

of speaking plainly to the public on this subject since knowledge drives away fear. "We should fear the beginning not the end of cancer. In all forms of cancer, fear of the disease comes too late." He pointed out the various means whereby the public may be educated in health matters and offered the facilities of his organization for this purpose.

Dr. A. C. Hendrick pointed out the great need of research in cancer, and suggested that surgical treatment in this affection has almost reached its limits. While irradiation was most useful in treatment, new methods must be looked for. The problem should be approached through the blood stream. Dr. Hendrick and Prof. Burton are now engaged in experimentation on inoperable cases with a colloidal solution of arsenic.

Interviews with individual practitioners in Ottawa, Peterborough and other places, revealed that in these places there were small quantities of radium in private hands or in group clinics.

Montreal

Radio-therapeutic work in Montreal is carried on chiefly in the Montreal General and Royal Victoria Hospitals and in the Radium Institute.

In the Montreal General Hospital there is one director for radium and another for X-rays. The hospital has seven-tenths of a gramme of radium—all in element, and everyone is given treatment whether able to pay or not. The funds for radium were supplied by a local donor. There is an excellent record system. Follow-up of cases is carefully carried out through a social service and by means of letters to patients.

From April, 1930 until September 16th, 1931, 473 new cancer patients were treated. Good results were claimed in cancer of the cervix of the uterus, in surface cases and those of mouth and throat. The method of low intensity and long period is followed. There is one 200-kv X-ray machine and one for diagnosis. The X-rays are used in breast cases before and after operation. There is a radio-therapy committee, comprising the heads of the hospital services, which has custody of the radium and assigns the cases to the proper quarter. The radiologist does not use the radium in cases belonging to other services. In spite of the rather cramped quarters, there is evidence that careful work is being carried on.

Drs. Henry and Ritchie have charge of radium and X-ray work respectively.

The Royal Victoria Hospital has one-half a gramme of radium and an additional twenty milligrammes were being received at the time of our visit. There is one 200-kv X-ray machine. The quarters are excellent and a large number of cases are treated. Preference is given to the low intensity long period plan of treatment by radium. There is no emanation. The Director, Dr. A. Howard Pirie, says the initial results of radium treatment are remarkable but he is most cautious as to the final results. In both forms of irradiation, the usual methods are pursued. Surface, buccal, throat and uterine cervix cancers seem to be greatly benefited. The record and follow-up system is excellent. Very fine work seems to be done in this clinic.

The Radium Institute of Montreal, under the direction of Dr. E. Gendreau, and associated with the University of Montreal, has twenty beds, one and one-quarter grammes of radium, of which one-half gramme is in solution, one 300-kv. machine with two tubes and one 200-kv machine with three tubes.

There is a large outdoor clinic and a small pathological department with a promise of better quarters as soon as the large new university buildings on the

north side of the mountain are completed. The record and follow-up system is excellent, showing ninety per cent. return of patients at intervals of three, six and twelve months for five years. In case of the poor, transportation is paid.

Radium element is used in cancer of the uterine cervix along with the external use of X-rays, the latter being used before and after operation in suitable cases.

Section II

INVESTIGATIONS IN THE UNITED STATES OF AMERICA

MEDICAL SERVICE FOR CANCER

In 1927 the American Society for the Control of Cancer appointed a committee of prominent physicians to report on the best methods of improving the service to the cancer patient. This committee found that studies of the question in Europe and elsewhere accentuate the view that improvement in cancer service must precede any substantial progress in cancer control.

The conclusions, which may be found in the complete report issued by the Society, are of some length and should be read in their entirety by those interested in this subject.

They are briefly summarized as follows:

1. The care of cancer patients requires special training.

2. A partial survey and a general review of conditions in the United States reveal notable deficiencies in the facilities for diagnosis, special equipment of hospitals and provision of experience and skill in the surgical and radiological treatment of cancer cases. Many of these deficiencies can be remedied by better organization of the cancer service.

3. (1) The establishment of a limited number of large cancer institutes, fully equipped for diagnosis, treatment, research, and education of students and specialists, is recommended.

(2) The establishment of special cancer hospitals where the local conditions are favourable and the material resources are adequate, is approved.

(3) The organization of the cancer service in general hospitals, with the object of concentrating the control of patients in order to secure better results in diagnosis, treatment and estimation of results, is particularly recommended.

(4) Deficiencies in the laboratory diagnosis of cancer is one of the most serious obstacles to an efficient service Effort should be made to increase the competence of pathologists who undertake to diagnose tumours, and this work should be gradually concentrated in universities, hospitals or state laboratories which are known to be provided with men of wide experience in the field of tissue diagnosis.

Buffalo

The State Institute for the Study of Malignant Disease at present under Dr. Burton J. Simpson, Director, was organized in 1898 by Dr. Roswell Park as a pathological laboratory for the study of cancer, and in 1902 was placed under control of the State Department of Health. This laboratory was the first in the world established for the exclusive study of cancer.

In 1913 a hospital of twenty-five beds was erected by private subscription, and in 1930 the Legislature appropriated $225,000 for the purchase of radium. An emanation plant was constructed, and radium placed in solution for use in treatment of cancer. This form of the use of radium is much more general in the United States than in European countries, where the use of the element is the usual method employed.

The institute is in the hands of a director who has complete charge. There are well-developed pathological, bio-chemical, physical, and hospital departments, each headed by a specialist with a staff of qualified workers.

The pathological laboratory undertakes the free microscopical examination of pathological specimens sent from hospitals and physicians throughout the State and these specimens average 12,000 a year.

The equipment includes 7.77 grammes of radium, of which two grammes are in solution, four grammes in the form of a pack or "bomb" and the remainder in needles and other containers. There are two high-voltage X-ray machines. The institute has now thirty beds, which, with those in the General Hospital across the street, afford ample facilities for the medical and surgical treatment of the 1,500 new cases which attend in a year. Here, as elsewhere, is heard the lamentable complaint that "unfortunately the majority of patients received are advanced cases." There is a well-stocked library, an elaborate record system and an excellent social service follow-up of cases. The institute is supported by the State, and notwithstanding the advanced character of the cases received, the results are remarkably good. It is a well-managed and well-equipped institution and is most popular with the public.

Boston

The State of Massachusetts has a population slightly higher than that of Ontario, contained in about one-fiftieth of our area. Massachusetts has always held a pre-eminent place in public health work in North America. In the tuberculosis movement and in the anti-cancer campaign the State was early in the field in adopting the use of modern methods. Dr. George H. Bigelow is State Commissioner of Health. Massachusetts has the highest recorded cancer rate of any State in the United States. There are about 5,000 deaths from cancer each year, and it is said that there are approximately 11,000 cancer cases. Here, too, it was found that the patients came too late for the most successful results of treatment. This delay is said to account for at least 1,000 deaths a year.

In addition to special facilities in hospitals in Boston, the State Health Department has control of a special hospital for cancer cases at Pondville, outside the city, with 115 beds. There are also fifteen diagnostic clinics located in hospitals in the larger towns throughout the State and these contribute most of the cases sent to this hospital. There is a free diagnostic laboratory service. If able, the patient pays $1.50 per day while in hospital, the State contributes $2.50 per day. "Residence" means that one has lived five years in a municipality. All residents are admitted whether able to pay or not.

The hospital, under the superintendency of Dr. G. M. Sullivan, is staffed by highly qualified surgeons, radiologists, physicists, and laboratory workers. Social follow-up of cases is carefully carried on. The records of cases are well kept. There is one gramme of radium in solution and 200 milligrammes in needles and other containers, the use of the former, however, being preferred.

There are two high-voltage X-ray machines and as elsewhere great pains are taken to protect the staff against any ill effects of the rays. The research work of the hospital is carried on at the Huntington Hospital in Boston. The director of the adult hygiene division, Dr. H. J. Lombard, under whose administration the cancer work of the State is supervised, is of the opinion that treatment of cancer should be carried on in general hospitals already possessed of facilities for this work. He favours the improvement of such facilities rather than the development of special cancer hospitals. Both he and the State Commissioner of Health favour frank discussion of cancer with the public.

New York

New York City has a large number of institutions for the treatment of cancer. The municipality provides hospitals for free treatment of the sick poor of all kinds and in 1930 approximately 7,000 cases of tumours, benign and malignant, came under the notice of the hospital division. Cancer cases may be sent to any of the municipal hospitals, but as far as possible these cases are segregated in units of the general hospital scheme where special treatment can be provided. The largest unit of the kind is in Bellevue Hospital, which has special facilities for the use of radium and X-rays, and where extensive research work is carried on. There is a special cancer hospital in Manhattan, another in Brooklyn, and a custodial hospital on Welfare Island for the care of advanced cases. The municipality possesses five and one-half grammes of radium, and an emanation plant. A scientific commission examines and evaluates all "cures" offered for cancer, provided that these are submitted according to the simple rules established.

The city has approximately 838 cancer beds, and many of the general hospitals receive large numbers of cancer cases. Mount Sinai Hospital for example, treated nearly 700 cases of cancer last year.

There are nine special cancer clinics in the city, with 5,000 patients, and 41,350 visits.

There is an institute of cancer research at Columbia University, and an elaborate equipment for this purpose at the Rockefeller Institute.

The Memorial Hospital, the irradiation department of which is under Dr. Douglas Quick, is an outstanding cancer research and treament institution, to which there are more than 2,000 admissions a year. This hospital dates back to 1884, and has 101 beds. It is supported by local philanthropy and municipal aid The hospital has four grammes of radium in a pack or "bomb" and the same amount in solution. There is an excellent high voltage X-ray equipment of at least seven machines. A 900,000-volt X-ray machine has recently been installed but was not yet in use at the time of the visit of the Commission. The favourite method of employing radium is by emanation, from the element in solution. Both radium and X-rays are in use continuously day and night, and large numbers of patients are treated. Dr. James Ewing is Director of laboratories. For research purposes there are departments of physics, biology, chemistry, and animal experimentation. The departments of surgery, internal medicine, pathology, radiology, and bio-chemistry are headed by eminent specialists in the different lines of treatment and study. The clinical department is in charge of Dr. Burton J. Lee. There were 2,324 new patients in 1930. All cases are carefully recorded and the follow-up of patients is very thorough. The institution claims successful results rising from zero to ninety per cent. depending on the type and locale of the growth, with an average of twenty per cent. in all cases. The daily cost of treatment averages $8.00 per patient and the annual cost of maintenance half a million dollars. All cases, other than hopeless ones, are admitted, and if patients are unable to pay, the city assumes the expense for residents of three years' standing. This is an excellently managed institution, with a wide reputation for first-class work.

Philadelphia

The study and treatment of cancer are well developed in Philadelphia. The Graduate School of Medicine of the University of Pennsylvania, under the direction of Dr. Ellice McDonald, has three laboratories, two of which are

associated with cancer clinics while the third is a purely research laboratory. The clinical laboratories are situated in the Oncological Hospital and the Philadelphia General Hospital, respectively. The central laboratory, purely for research, has twenty-one rooms and a fine library.

The central laboratory carries on research in chemistry, physics, tissue culture, etc., while the other laboratories confine themselves to work in biochemistry, cell morphology and the immunology of cancer. There is a division of animal experimentation.

Besides these institutions there are the Philadelphia Cancer Hospital at Ambler, the Skin and Cancer Hospital, and Jeanes Hospital.

The Oncological Hospital has forty beds for cancer and a large outdoor clinic. The Hospital possesses 426 milligrammes of radium, deep X-ray therapy, an emanation plant, as well as a research laboratory. Our observance of an outdoor clinic indicates the close co-operation of the whole staff in cancer diagnosis and treatment.

The clinic at the Philadelphia General Hospital is a good example of one carried on in a general hospital. This plan is favoured by Dr. J. B. Carnett, Chief of the surgical staff. There are eighty-eight beds for cancer, all on one floor, two grammes of radium, high-voltage X-ray and an emanation plant. The use of emanation rather than of the element is favoured as being more flexible and less subject to loss of material. Associated with the director is a staff of salaried specialists and a number of others serving half time. Practically all cancer cases admitted are referred to the clinic; ultimately all reach the clinic.

There is an excellent record system, and follow-up of cases is regarded as essential to success. Both radium and X-rays are used in association with surgical treatment, in suitable cases. Treatment is begun immediately after arrival. The cost per patient is $3.50 per day, while that at the Oncological Hospital is $8.00 per day. Two-thirds of the cases are pay patients. There is a post-graduate course of three months for medical practitioners.

Education of the public is carried on through the City Medical Society and by the local department of health.

Baltimore

Baltimore is a pioneer city in the use of radium in cancer therapy, and this agent is highly regarded by the leading authorities there. The chief institution for this type of treatment is the private hospital of the eminent gynaecological surgeon, Dr. Howard Kelly. At this institution there are five grammes of radium, all in solution, an emanation plant and a first-class X-ray equipment. The radium element is not used. Dr. Kelly is of the opinion that all cancer work of a city should be in one centre either as a separate institution or as a division of a large hospital. He expresses the opinion that by irradiation nearly all accessible early cancers are curable. The advanced are rarely cured, but always palliated. In internal cancer, he thinks irradiation is not promising.

At the Johns Hopkins Hospital where the large proportion of cancer cases are hospitalized a tumour conference under the direction of Drs. Bloodgood and Geschickter, for medical practitioners from all over the country is held at intervals for a period of three days. At the time of our visit about 100 men and women were in attendance doing practical work in tissue diagnosis. Teaching of this kind should be of singular value.

Education of the public and of the medical profession is regarded among Baltimore men as one of the important elements in cancer control. The public should be taught the necessity of seeking medical advice at the earliest moment

in respect to moles, growths, unhealing sores and irregular haemorrhages; and after forty, they should be taught the value of periodical health examination. The latter, in women, should include a pelvic examination, and any suspicious case should be thoroughly gone over with laboratory check and biopsy of the growth. There should be supervision of cervical and other pelvic conditions, of teeth and mouth conditions, prostatic affections, and the so-called haemorrhoids.

In the case of doctors it was pointed out that more mistakes are made through slovenly methods of examination of cases than from lack of knowledge. All routine examinations should be thorough and suspicious signs should be carefully scrutinized. The doctors should be on the alert for the danger signals of cancer. The frequent complaint at all clinics is that there is a deplorable waste of life because of late diagnosis and that this condition is due to the combined neglect of patient and doctor.

Dr. Thomas S. Cullen, the well-known gynaecological surgeon of Baltimore, sends all his cases of cancer of the uterine cervix for radium treatment. He is highly impressed by the value of radium in such cases. To him, as well as to Drs. Bloodgood, Kelly and Geschickter, the Commission is much indebted for assistance in gaining extensive information in respect to the problem of cancer control, for useful literature, and for illuminating correspondence on the subject.

One could not fail to be impressed by the quiet enthusiasm of the leaders in this great medical centre and by the thoroughness and meticulous care in the treatment given.

Chicago

Tumour Clinic—Michael Reese Hospital

In addition to radio-therapeutic work at various hospitals in Chicago, a special tumour clinic has been established at the Michael Reese Hospital. The term "Tumour Clinic" is used, as the Director, Dr. Max Cutler explains, because people will come to a clinic so named when they will not attend a "cancer clinic." Moreover, not believing that they have cancer they will appreciate the need of an X-ray of the stomach for other disorders.

It is proposed to use this clinic for diagnosis and treatment, and to develop its use as a centre for post-graduate teaching in radio-therapy.

The Director is an advocate of the use of the Columbia paste of Regaud, in moulds for the application of radium. He favours the low intensity and long period use of radium and prefers the element to the emanation. He is strongly of the opinion that both doctors and the public need much education in respect to cancer and that only the expert should be allowed to treat the public by means of radio-therapy. He is also of the opinion that in all the more important cases of cancer, there should be consultation between the various services to determine the best method of treatment, and that if the use of irradiation is decided on, it should be administered by the radiologist and not by the surgeon.

The Director, viewing the situation in Ontario, is of the opinion that it would be advisable to start one complete clinic with auxiliary services of laboratories for research, and, when properly trained men are available, to add a clinic at each medical teaching centre. Diagnostic centres might be established to serve the more remote areas.

Cancer Laboratories of the Otho S. A. Sprague Memorial Institute

Maud Slye is one of the best-known laboratory workers in America and perhaps the greatest proponent of the theory of cancer heredity. She very

strongly holds the view that the devotion of effort to *cure* should be supplemented by an equal or even greater effort to *prevent*. She would like to see large sums of money spent in training men and women to recognize cancer and to handle cancer cases as specialists.

Miss Slye thinks our present statistics of cancer are unreliable, since the autopsies of large hospitals show that many patients are wrongly diagnosed as cancerous, and that many treated for some other affection really die of cancer which is unrecognized.

Measures, she says, should be taken to teach large numbers of doctors how to diagnose cancer. She does not appear to place much stress upon the education of the public beyond what has already been done in this direction.

Not only in cancer, but in regard to all other diseases she deprecates a disregard of prevention. Most progress, she asserts with truth, has been made in disease control along preventive lines. As proof she instances malaria, yellow fever, diphtheria, scarlet fever, and other affections whose delimitation is a notable example of the value of preventive medicine.

The long experience of Miss Slye in studying the cancer problem in mice (with autopsies in more than 90,000 cases) invests her views with much authority. She claims to have established her theory of the heredity of cancer in certain strains of mice.

In addition to procuring radium, she offers the opinion that it would be advisable for the Government to spend a much larger sum in the establishment of an institute devoted to the entire cancer problem, to teaching and training specialists, to giving post-graduate training to general practitioners, to providing the best-known treatment for cancer patients, and to promoting cancer research.

Rochester, Minn.

The Mayo Clinic is a unique example of the growth, within two generations, of a medical organization from the country practice of a family doctor to one of 75,000 or more cases a year.

Situated in Rochester, Minn., a city of 21,000 people, the clinic is the dominant structure of the city and forms a sort of "clearing house" for the medical, surgical and other services. The clinic is the administration headquarters of the group of physicians, surgeons, radiologists and others who carry on work in the various hospitals of the city—the largest of which, St. Mary's, has 650 beds. At the clinic all records, histories, and other information in respect to patients, are kept and all initial examinations made. Since the various services are on a salary basis, there is the closest kind of co-operation. This condition materially lessens the difficulty constantly found elsewhere of one particular service dominating the whole.

The radium work, under the direction of Dr. H. H. Bowing, is chiefly carried on in the Worrell Hospital (200 beds). There are four grammes of radium, two of which are in solution for use as radon. There is no great preference in the use of one or other type of radium treatment; each one is used as seems best adapted to the case. Radium is highly regarded in treatment of cancer of the uterine cervix, of the body surface, of the mouth, lips and other readily accessible parts. The preference is for the low intensity, long period plan of treatment. The director would like the opportunity of trying the effect of a four-gramme "bomb" in certain types of cancer. At the Radium Institute outside the city, research work is carried on in extensive laboratories.

The X-ray department, under the directorship of Dr. A. U. Desjardins, is in the Curie Hospital where there are two high-voltage X-ray machines for

therapy and three for diagnosis. The films seen indicate the high quality of the diagnostic work carried on by Dr. Desjardins, who believes in the efficiency of still higher voltages than those in use at present. He has confidence in the use of X-rays for treating cancer of the breast and the sarcoma of the bone and showed some good results in the latter affection as well as in lympho-sarcoma, and in "Hodgkin's" disease.

Surgical treatment of cancer at the Mayo Clinic, as elsewhere, is so far the most widely used. Some members of the staff even go so far as to say that it is the preferred method for cancer of the lips. It is certainly so regarded for cancer of the abdominal organs. In breast cancer surgery is favoured and is usually followed by the use of X-rays. The first 800 cases of cancer of the stomach treated in the clinic, according to Dr. Donald Balfour, show 133 ten-year cures. The members of the surgical, pathological, and radiological staff consulted, were agreed that proposed cancer units for Ontario should be established in close connexion with large hospitals, not only to afford the opportunity of under-graduate study but chiefly to offer the best aid to the greatest number of patients. It was suggested that one first-class unit, embracing all phases of cancer work, such as laboratories, pathology and treatment should be set up in Toronto, and that as soon as qualified men could be secured, smaller units should be established in Kingston and London.

A campaign of public education was advised and it was urged that post-graduate courses for doctors should be arranged.

Section III

INVESTIGATIONS IN GREAT BRITAIN

GREAT BRITAIN

The British are a conservative people, and among no class in the British Isles is this universal conservatism in greater evidence than among members of the medical profession. While the profession is well to the front in the great branches of medical science and in cancer research, it was not until recent years that the continental interest in the newer field of irradiation therapy spread across the Channel. The surgical side of cancer treatment was already well developed. The cancer department of the Middlesex Hospital and the Fulham Cancer Hospital have long been known as outstanding institutes for the treatment of cancer. The English apparently do not fear to use the word "Cancer" and the Fulham institution has this name in large letters on its front.

The Imperial Research Cancer Fund was established by the Royal College of Surgeons and the Royal College of Physicians in 1900. It maintains a large laboratory of research, the Imperial Cancer Research Institute.

The Medical Research Council, a part of the King's Privy Council, has carried on investigations into the use of X-rays and radium since 1915, and in 1924 the Council provided 300 milligrammes of radium for the treatment of cancer.

The British Empire Cancer Campaign established in 1923, gave a great stimulus to public interest in cancer. This is a great organization for the purpose of advancing measures for the control of cancer, by public education, the organization of centres for treatment, and assistance given to those engaged in research Among the British Empire Cancer Campaign's publications are, The Cancer Review, a monthly journal of abstracts of articles on cancer, and a booklet "The Truth About Cancer." The organization is not confined to physicians and surgeons, many of the members are distinguished laymen. Capt. E. J. C. Chapman, M.C., Secretary, gave the Commission full particulars of the operations of the campaign and was most generous and obliging in furnishing it with copies of the various publications of this organization.

Sir George Newman, Chief Medical Officer at Whitehall, and Lieut.-Col. H. B. Smallman, C.B.E., D.S.O., M.D., director of the cancer work of the Ministry of Health, were of great assistance to the Commission in providing details of the cancer control work of the Ministry, and in arranging for interviews with authorities in Great Britain and on the continent.

London

London has five special cancer hospitals and two others are established in Manchester and Liverpool. All the voluntary and some special hospitals such as those for gynaecology and skin diseases accept cancer patients.

The National Radium Centres, of which there are seven in England, one in Wales, and four in Scotland, are associated with large teaching hospitals and the medical colleges of provincial towns. In addition to the Radium Institute in London there is the Radium Centre of the N. W. Hospital, Westminster Hospital Annex, the Marie Curie Hospital (for females), the Radium Centre at the Middlesex Hospital, the Cancer Hospital, Fulham Road, and the Radium Centre at Lambeth Hospital.

Most of the teaching hospitals provide post-graduate courses in cancer, and the Mount Vernon Hospital at Northwood has a definite post-graduate course on irradiation given four times yearly.

There are seven large laboratories in England devoted entirely to cancer research. In addition, in many of the large hospitals, research relating directly

or indirectly to cancer is conducted. In ten of the large cities such laboratories are subsidized by the British Empire Cancer Campaign.

The Ministry of Health has a departmental commission on cancer and arranges to collaborate in international enquiries on this subject. It has made numerous reports on special cancer subjects.

About three years ago a fund of £250,000 derived from public subscriptions of £150,000 as a thank-offering for the recovery of H.M. the King, and £100,000 from the Treasury, became available for the purchase of radium. A National Radium Trust and a Radium Commission were instituted, the former to take charge of the funds and to purchase the radium, the latter to make arrangements for its custody, distribution and use.

The radium thus acquired added to that already in the hands of various hospitals and centres makes the total quantity in the British Isles about sixty grammes.

Middlesex Hospital

This old-established hospital has a special cancer ward and also admits cancer patients to the general wards. It has one gramme of radium and a deep X-ray equipment, but the surgical idea predominates. The members of the staff include some of the most eminent medical and surgical leaders in the United Kingdom. They know thoroughly well their capabilities, and are slow to be diverted to what may seem to them uncertain channels of treatment. To them irradiation has yet to prove itself superior to surgery in the treatment of cancer. They agree that the treatment of cancer should be a combination of the use of surgery, X-rays and radium. The Middlesex hospital has more than twice the number of breast cases found in any other London hospital. Surgical treatment is favoured but is combined with the use of irradiation in suitable cases. Members of the staff point out that someone must take the ultimate responsibility for a patient's treatment. A patient cannot be under the care of a committee. The opinion of members of the staff was that cancer hospitals should be part of a general hospital scheme rather than separate institutions. Mr. W. Sampson Handley is Senior surgeon; Mr. Victor Bonney, gynaecologist; and Dr. Douglas Webster is honorary radiologist. Mr. A. W. Windeyer has charge of radium work at the Middlesex.

The Radium Institute

This institute, under the direction of Mr. Ward, is one of the National Radium Centres. There is one gramme of radium, in needles and other containers, and one in solution, for the supply of radon. The emanation plant is of the best type. There are thirty beds, of which one-half are for the poor. The institute is associated for treatment with the Mount Vernon hospital at Northwood.

Radon seeds are sent out to surgeons qualified to use them, but not to the general profession. The scope of radium in the treatment of cancer is considered to be limited to surface affections, the cervix of the uterus, the breast in suitable cases, the mouth and pharynx, and inoperable rectal cancer. Its use in the alimentary canal is not favoured. The use of the element is advocated, and low intensity dosage over a long period is preferred.

The support of the institute comes from endowments, fees of patients able to pay, and through supplying radon to practitioners. The average five-day cost to patients is twenty guineas, but many patients are treated free or at nominal cost.

Mount Vernon Hospital, Northwood

This institution, under the direction of Sir Cuthbert Wallace, beautifully situated at a high elevation, twenty miles north of London, is an experiment under the direction of the Medical Research Council. There are beds for 150 patients. Radium, X-rays and surgery are the established methods of treatment. It is one of the National Radium Centres, and patients coming to the hospital are diagnosed at the Radium Institute, or by men on the staff. Its distance from London precludes any great use as a teaching centre, although post-graduate training is given.

They have two and one-half grammes of radium, an emanation plant and ample X-ray equipment.

Results in radio-therapy of cancer of the cervix are said to be good; in buccal cancer, as good as with surgery, but further experience is said to be needed in cancer of this region.

The director favours the treatment of cancer, like other diseases, in hospitals, with centres for research and diagnosis.

The Westminster Annex, in Hampstead, under the direction of Mr. Stanford Cade, has beds for thirty patients. Here a "bomb" of four grammes of radium has been tried, but its use is not favoured, as it ties up too much of the element. Radium is otherwise used as emanation. It was pointed out that radium emanation should be carried out at the ground level, with ample ventilation, since radon settles to the lowest level and is dangerous.

The director thought that a cancer hospital should not be labelled with such a name, as this practice might deter patients from coming for treatment. The treatment of low intensity and long period is favoured.

Fulham Road Cancer Hospital

This is an old and outstanding institution for the treatment of cancer, where the term "Cancer" appears to excite no fear, since the name is set up on the front of the hospital. There are one and one-quarter grammes of radium, all in element, and one 200-kv. X-ray machine to which will shortly be added a more modern one. Extensive additions are being made to the hospital. Its 120 beds will soon be increased to 200, and large new laboratories will be added.

Professor J. M. Woodburn Morison, Director of the Radiological Department, expressed the opinion that physics and the physical laboratory form the whole basis of irradiation and that in this field the most important man is the physicist. "Physical research," he says, "is the brains of cancer work."

Considerable laboratory work has been done in the hospital on carcinogenic compounds. With the new and extended laboratories and the enthusiasm which is evident among the personnel of the institution, one would expect valuable results.

The Senior surgeon of the hospital, Mr. R. H. Jocelyn Swan, regards cancer treatment as team work. He seems impressed by the value of irradiation treatment and is of the opinion that a low intensity of radium over a long period gives the best results.

The Fulham is one of the best institutions your Commission has seen.

The London Hospital

Dr. Arthur Burrows is the Radiologist at the London hospital, and was responsible for the organization of radium and X-ray work in Australia.

In an interview, he pointed out that radium technique changes from time to time. He was of the opinion that radon has its place in treatment, especially in a large centre, where adequate personnel should be available.

He believed that a diagnostic centre should, for economy, be in a large hospital where there are pathological laboratories and competent staff and where weekly consultations should be held.

The interview was largely a discussion of the organization in Australia, taken up in detail elsewhere. See Appendix "C."

Dr. Thos. Lumsden, Director of the Cancer Research Laboratory, London Hospital, has some original views about cancer. He believes the cure may be sought as follows:

(1) The cause may be investigated and if found, may prove to be preventable or tractable.

(2) Some serum, drug or radiation may be discovered, so specifically injurious to cancer cells that these can be destroyed without injury to normal tissue cells (something like arsphenamine in syphilis). If this were forthcoming, the body could be sterilized or freed from cancer cells as often as required.

(3) Some means may be sought by which the body can be rendered resistant or immune to invasion of its normal tissue by the cancer cell, so that any existing cancer would disappear, and recurrence would be impossible (i.e., some means of evoking "tumour immunity").

Dr. Lumsden is working along the latter lines (No. 3), his views resembling to some extent, those of Murphy, H. Cramer, Magat and Maisin.

A long series of experiments, both in the laboratory and in the bodies of animals by Lumsden, lead him to conclude:

(1) That anti-malignant-cell bodies lethal to cancer cells but harmless to normal tissue cells, can be produced.

(2) That when an implanted tumour already established in the body is gradually destroyed by injecting antiserum or formalin into it, active immunity against the tumour is induced by a mechanism, which may be called autovaccination.

It has still to be discovered whether or not similar results can be obtained in the case of spontaneous tumours.

He says further:

"The term 'cure' in relation to cancer, has a double significance: (1) the disappearance or removal of the existing new growth, and (2) the induction of some mechanism which shall prevent recurrence. Surgery and radiation achieve the first object more or less satisfactorily but have little, if any, power to produce immunity.

Autovaccination by inoculation by antiserum is an excellent method of evoking immunity, but it is not easy to maintain a concentration of antibodies in the tumour area sufficient to destroy all the cancer cells. Formalin as a reagent stands between antiserum and radiation. It is a less potent immunizer than antiserum, but more powerful as a destroyer of the existing growth."

Lumsden regards as the most hopeful means of attaining the "cure" of cancer:

(1) To inoculate antiserum into the primary cancer (or to the arteries supplying it), localizing it there by constriction or adrenalin, and

(2) If necessary thereafter, to complete by surgery or radiation the local destruction of the tumour.

Manchester

The Radium Institute, which has a number of beds and an outpatient department, handles all the radium for Manchester, and the radiologist goes to associated hospitals to consult with surgeons and to use radium. There is a high-voltage X-ray equipment.

Christie Cancer Hospital is just across the street from the institute. It has thirty-four beds for cancer cases, and works in close association with the institute. Too many of the cases are far advanced. The surgeon dominates the hospitals for cancer cases, but radium treatment is the method chosen in treatment of skin cancers, cancers of the lip and tongue, and cervix of the uterus. Operable breast cases are operated upon and radium used in the axilla. Later, high-voltage X-rays are used as deemed advisable by the radiologist.

There is a Manchester Research Commission with a laboratory in the University. Work is being carried on particularly in the carcinogenic agents in shale oils.

A pathologist is working on the effect of the posterior lobe of pituitary gland in cancer, and has found that he could cause the disappearance of growths in mice by the use of serum from the gland. (See Susman, Br. Med. Jl., October 31st, 1931.)

Liverpool

Professor W. Blair Bell has been investigating the effect of colloidal and organic compounds of lead on cancer. He was induced to try lead as an anti-cancer agent owing to its being practically the only abortifacient that is reasonably certain, even though in using it the patient herself gets a toxic dose of lead. Arguing that in cancer we are dealing with embryonic types of cells and that these cells might be amenable to lead, he started experiments over 25 years ago. He has had his best results with certain colloidal lead preparations, and with large doses he claims some cures. He has been using some organic lead compounds synthesized in their bio-chemical laboratories, which gave in animals 80 per cent. to 90 per cent. of cures, but in human beings only 10 per cent. to 25 per cent. Professor Bell uses lead in inoperable cases only.

Recently the Koch Institute of Berlin, manufactured an organic lead No. 232, which, while carrying 50 per cent. of lead in its molecule is said to be feebly toxic to normal tissues, to be readily soluble and easily excreted. It is said to give a high recovery in cancer of animals. Investigations with the preparation are now underway.

The surgeons in Liverpool seem lukewarm toward the use of X-rays and radium in treatment of cancer.

Aberdeen

Professor Catto of the *Royal Infirmary* showed the emanation plant with 300 milligrammes of radium in solution. Apparently no research work is carried on.

Dr. Evans, the Radiologist, said that the routine treatment of cancer of the breast was by radium needling followed by surgery and radium.

Cancer of the uterine cervix, superficial and buccal cancer, are all treated by radium. Cancer of the glands of the neck are treated by a radium pack and operation The radiologist has the right to see all cases of cancer which reach the infirmary. He has a high-voltage X-ray machine which is used in cases of cancer of the uterine cervix and lympho-sarcoma before operation. He prefers radium to X-rays in cancer cases.

There is no set educational programme, but in 1931 about 50 practitioners were given instruction in the use of radium.

Apparently there are no statistics of the work carried on.

It was a pleasure to meet Professor J. J. Macleod, former Professor of Physiology in the University of Toronto, who is engaged among other matters in making further research in connexion with diabetes.

Edinburgh

At the *Royal Infirmary*, Professor Sidney Smith and Dr. Thomson were interviewed.

The infirmary has two grammes of radium in needles, packs and other containers. There are two X-ray machines of 220,000 volts and two of 110,000 volts.

Blue and red tags attached to a wall-board, corresponding to units of radium indicate the whereabouts of the radium. The red tags show the units in use, as well as the ward where they are. The blue tags indicate the units not in use.

A surgeon on the staff is allowed to take the radium owned by the infirmary outside for his private cases. He signs a form describing the units taken and the estimated time in which they will be in use. The radium loaned by the Radium Commission is not allowed to be used outside the infirmary.

Statistics respecting cancer cases were not available.

In cancer of the uterine cervix the surgeon attending the cases uses the radium. Six weeks after its use high voltage X-rays, four treatments in a period of eight days, are given.

X-ray films are taken of the needles *in situ* in breast cases. Long three-milligramme needles are used in these cases. Mr. Shaw pointed out that the routine plan of treatment in breast cases was X-rays followed by surgery and X-rays.

In cancer of the uterine cervix radium is the chief form of treatment. High-voltage X-rays are used in cases of cancer of the body of the uterus. In stomach cases surgery is still the method of treatment.

Section IV

INVESTIGATIONS IN EUROPEAN COUNTRIES

FRANCE

Cancer work in all departments is highly developed in France. As far back as 1842, a charitable lady, Madame Veuve Garnier, of Lyons, temporarily opened her home to poor women stricken with cancer and afterwards founded the first of the institutes known as Calvaries. There are now eight of these special hospitals (including one for men) in France, where incurable cases are cared for.

In 1908 the "French Association for the Study of Cancer" was founded to promote research, and in 1918 the "Franco-Anglo-American League for the Control of Cancer" was created for the purpose of arousing interest among the public in the cancer problem and of providing increased facilities for treatment.

Paris

The *Radium Institute* was established and began its work in 1910. By 1921 the Council of Paris had set up radium services in several of the city hospitals, and the Department of the Seine in the same year began a cancer centre at Villejuif in the suburbs.

In 1922 the Ministry of Health organized cancer centres in all the medical schools of France, provided them with radium and X-ray equipment, and gave them state support. There are sixteen such centres for treatment outside Paris—too many—according to those of the highest authority. At any rate, the results appear to be satisfactory, and France may well point with justifiable pride to her efforts in the control of cancer.

The *Radium Institute of Paris* consists of two parts:

1. A laboratory of physics and chemistry, under Mme. Curie.

2. A laboratory of research and polyclinics, and two hospitals for the treatment of cancer.

In the institute there are eight grammes of radium, of which 260 milligrammes are in solution, and eight high-voltage X-ray machines.

The personnel of the institute is salaried and under a board of directors. The laboratories are the property of the University of Paris. The project is a State one. The budget is 1,500,000 francs (the franc being about four cents), and 200,000 francs come from donations. The aggregate fees, which are applied for the benefit of the institution, amount to 900,000 francs. The poor are treated free. Six Paris hospitals have a radium-service from the institute.

The Director of the Institute, Professor Cl. Regaud, and Professor Gustave Roussy of the Villejuif clinic are of the opinion that there are too many treatment centres in France, that it is better to have a few first-class centres and to bring patients to them, and that an institute for cancer should be under control of the university from the scientific point of view, and of the State from the financial point of view.

Highly-trained personnel is essential to gain the best results. The director of the institute favours an internist as head of a cancer centre. In the use of radium he advocates a low intensity over a long period, and he uses radium or X-rays in situations where they are calculated to give the best results. A supply of two grammes of radium for each million people is his estimate of requirements.

In the experience of the director the best results from irradiation are found in cancer of the skin, mouth, lips, and cervix of the uterus. These, under favourable conditions, may be cured. In the institute there has been no success in irradiation treatment of the internal digestive organs, except in some rectal cases. In breast cases surgery is preferred. Prophylactic radiation is not used.

The laboratories of the institute are well-equipped, the records well-kept, and cases are followed for long periods. Preference is had for Columbia paste (a mixture of sawdust and wax) in the preparation of moulds and applicators in the use of radium.

There is an up-to-date emanation plant. Indeed, the institute is one of the best in equipment, personnel and clinical results to be found anywhere. Of 212 cases of cancer of the uterus of one, two, three degrees respectively, treated in the period 1919–21, statistics of five-years' cure are twenty-six per cent., twenty-three per cent., five per cent.—average fourteen per cent. In 293 cases, 1922–25, similar statistics show seventy-five per cent., thirty-eight per cent., twenty-seven per cent.—average thirty-two per cent. The total cases show an average five-year cure of fifty-one per cent., thirty-one per cent., nineteen per cent—average twenty-four per cent. The director claims a cure in fifty per cent. of early cases of cancer of the tongue, and twenty-five per cent. if the glands are affected. He has eighty per cent. of primary lip cures. Despite the fair results achieved, there is in the institute as in Great Britain, a conservative attitude towards the use of radium and X-rays.

Radium Institute, Villejuif

The institute of cancer research and treatment at Villejuif on the outskirts of Paris is attached to a large and modern general hospital with attractive grounds and buildings. There are sixty beds for cancer, and the number is soon to be increased to one hundred. The radiologist is a woman physician, Dr. Simone Laborde. About 1,500 cancer cases are treated each year.

The research laboratories are very extensive, modern, and complete, costing 900,000 francs a year. A "bomb" of two grammes of radium has been in successful use for the past year.

While Professor Regaud of the Radium Institute advises against the use of the term "Cancer" in the designation of a centre, Professor Roussy, the Director at Villejuif, favours its use. These French clinics are amongst the best we visited. The respective directors have an international reputation in radio-therapeutic work.

BELGIUM

Belgium, because of the fact that she produces ninety-five per cent. of the world's annual output of radium is in a unique position in respect to this type of treatment. There are five cancer centres.

Each of the four medical schools of the country has an official cancer centre; the fifth is connected with the Brussels Surgical and Radiological Institute. Each centre has two grammes of radium, a complete surgical service, high-voltage X-rays and a highly organized laboratory service. One-eighth of the rad um is used in research and the remainder for treatment. There are two additional diagnostic centres, all being under the State and in receipt of government subsidies. The staff in the centres are salaried officers. There is close government inspection and scrutiny of reports, but there is no interference with methods of treatment nor with lines of investigation. The opinion was

expressed that there would be better results if there were fewer treatment centres and more diagnostic ("spying") centres. "Follow-up" of cases is regarded as essential and elaborate measures are taken to ensure the regular return of patients. Great stress is laid upon public education. Cancer education and advertising of the spectacular kind are utilized and are in the hands of "The National League against Cancer." The motto is "Cancer taken early is curable." All educational work in cancer is paid for. Voluntary help in the cancer campaign has been abandoned. The cured patient is regarded as the best advertisement. In health education advantage is taken of the great number of societies (some 1,500), in Belgium. Everyone belongs to a society, and through combinations of societies people are gathered in a feste to hear lectures on cancer. Mr. Willem Schranen is Secretary-General of the National League.

The expenses of the League are defrayed by the government, the municipalities and from private donations. The cancer work is under the Ministry of Health. It is said to be very easy to obtain money in Belgium for hospital or charity funds.

Brussels

The Surgical and Radiological Institute,
Dr. Felix Sluys, Director.

This is one of the five cancer centres of Belgium, a government and municipal institution with forty-five beds, a 200-kv. X-ray apparatus, and a radium "bomb" of 240 milligrammes. Emanation is not used. Some excellent clinical work was observed. Radium is used by the low intensity and long period method. Satisfactory results in cervix and surface cases are obtained as elsewhere. In breast cases, they use X-rays, surgery and finally X-rays.

The Brugmann Hospital

This is a teaching hospital of 3,000 beds, situated in large grounds and established on the one-storey pavilion plan. There are forty-five beds for cancer cases. There are ample radium and X-rays. There is a special "follow-up" social service. In this centre a wax material called Nidrose is used for applicators. It is moulded readily at 120° C. and to it may be attached buds of white wax in which the radium is embedded. No emanation is used. The laboratories are extensive.

Louvain

Institute St. Raphael

The cancer centre at Louvain attached to the University of Louvain, is directly in charge of the Professor of Pathology, Dr. Maisin, who has a high reputation not only in this field, but also in the fields of radiation and clinical surgery. The cancer unit of fifty-five beds, while located in the hospital, is absolutely independent in its organization. The new medical school of the university is attached to the centre and there are 900 medical students.

The entire hospital has 215 beds. There are three to four grammes of radium and four high-voltage X-ray machines. The laboratories for research and animal experimentation are extensive and anyone may pursue cancer research there.

The results obtained from the use of irradiation in the uterine cervix, the skin and lips, are similar to those secured elsewhere. Prophylactic X-rays are used in breast cases. The director is using a tissue extract made from normal spleen, brain or thymus of beef. At the time of the visit of the Commission, 122 inoperable cases were under treatment. Some success is claimed for this method. The extract is made by fractioning the fat and lipoid extracts of the normal organs; the lecithin-contained fraction is injected about the growth and in internal cancer subcutaneously.

GERMANY

In Germany, since 1900, the spread of public education about cancer has been in the hands of the German Central Committee for the study and control of cancer. By means of pamphlets and letters there has been active instruction of the physicians, the public, nurses and midwives. There is a free service for the diagnosis of tumour specimens.

Cancer institutes have been established in Berlin, Heidelberg, and Hamburg, the first two with bed space and the latter for research work only. Germany does not favour special institutes for cancer treatment, because of the danger of creating a fear of such places. Most cases are treated in ordinary hospitals.

While supplies of radium are very meagre in Germany, she has kept abreast of the times in cancer research. In the effective application of this knowledge to patients she does not seem to have made equal advance.

Berlin

Charité Hospital

In association with irradiation in this hospital, certain chemicals are injected prior to the use of X-rays and radium. It is claimed that colloidal solutions of certain aniline dyes or tuberculine improve the effect of X-rays. A tissue extract of similar type to those in use at Louvain is employed. The experiments under the direction of Professors H. Cramer and Magat form a subject of great interest, of which much more may be heard.

University Polyclinic

Professor Dr. Blumenthal is the director and Professor Halberstädter is the radiologist. There are two water-cooled high-voltage X-ray machines. There is one gramme of radium, the element being used. The clinic possesses what is said to be "the smallest emanation plant in the world" (50 milligrammes). It is a metal cylinder one and one-quarter by four inches with a tube of six or eight inches. It is known as dry emanation and is said to be even more effective than the emanation from a radium solution. The clinic treats 1200 cancer patients a year.

The Kaiser Wilhelm Institute for Zellphysiologie

This institute, established chiefly by Rockefeller Foundation benefactions, is doing biochemistry work. About a dozen men are engaged here in scientific investigation. At present the chief research work carried on is on oxidation in both normal cells and cancer cells. The director, Professor Otto Warburg, who is the Nobel prize-winner in medicine for 1931, thinks that so far no chemical substance of value in cancer treatment has been found.

Hamburg

The *Cancer Institute* in Hamburg is used entirely for research; there are no facilities for treatment.

One of the principal hospitals of the city, St. George's, with 2,000 beds, has facilities for irradiation treatment. The director is Professor Dr. Holthusen. There are three high-voltage X-ray machines of the type seem in Frankfort but the distant rather than the compression treatment of Holfelder is used. Radium, both element and emanation, is employed in suitable cases. The emanation plant is very small and compact.

There is a large department for diagnosis as well as for treatment in many non-malignant affections. The total reaches 30,000 cases a year. The slides, photos, and films of cases shown the Commission were very extensive and of the highest quality.

Frankfort

The *Institute* in Frankfort is part of a civic hospital and is under the direction of Professor Dr. Holfelder. The hospital possesses one of the best equipments of X-rays in the world. The building apparently has been erected for this special purpose. The ground floor is taken up chiefly with diagnostic rooms. There is special separate diagnostic equipment for almost every region of the body. All attendants are thoroughly protected against the action of rays by lead and barium plaster. There is a consulting room for the daily consultation of the staff and the corridor wall is lighted to show X-ray films. The generating rooms are on the next floor, and the third floor is devoted to treatment, records and laboratories. There are six tubes for deep therapy. No radium is used. The applicator of the cannon is pressed deeply into the tissues of the breast, abdomen, etc., in treatment, so as to get as close as possible to the growth, and to compress the blood out of the skin, which, it is claimed, is thus rendered less radio-sensitive. The director uses high-voltage X-rays for breast and all cases of cancer, before and after the operation, or in certain cases, alone. It is claimed that X-rays are best for deep-therapy work, for rectum, breast, and throat, and radium best for skin and mouth. The basement is occupied by electrical apparatus for diathermy, also by sun lamp treatment for rickets and marasmus in children, and by a direct current for cancer of the skin. This is a very complete institution for treatment by X-rays. Last year, 13,000 to 14,000 patients were treated by deep therapy, of whom about 10,000 were cancer. Results in cancer of the stomach appeared to be good. The director claims four or five cures of cancer of the stomach by X-rays. We saw films of three cases of cancer of the stomach treated one and one-half years ago with no apparent return of the disease. The director thinks there is no better X-ray apparatus than the 200,000-volt machine. He is of the opinion that higher voltage will do more harm than good. The records of the institution are excellent but there is not a complete follow-up of cases.

SWEDEN

Sweden has made great advances in the solution of the cancer problem. In care of patients, in details of organization and in follow-up of cases, her programme is one of the best to be found in the world. This organization, conceived by a surgeon, John Berg, has been developed largely through the genius and capacity of its present Director, Dr. Gösta Forssell, and his assistants.

Stockholm

Radiumhemmet

The chief centre for active treatment of cancer is the Radiumhemmet ("Radium home") in Stockholm, where there are sixty-four beds for cancer patients, with twenty-one and eighteen respectively at two other centres, viz., Gothenburg and Lund. A new hospital of one hundred beds is projected for the Radiumhemmet. Of all cancer cases Stockholm receives 55.46 per cent., Gothenburg 22.16 per cent., and Lund 22.38 per cent.

There are ten grammes of radium for the three centres and no emanation. A small quantity of radium is held by some five other institutions, but these are not encouraged to do radio-therapeutic work. Twenty-eight hospitals of the country are used for diagnosis, under men trained at the Radiumhemmet. Most of the X-ray diagnostic work is done in the large hospitals of Stockholm. At the Radiumhemmet they use a bomb (three grammes) of radium with good effect. There is ample X-ray equipment which is extensively used in cancer treatment.

As in Great Britain, most of the funds for the purchase of radium came from the public as a gift to His Majesty the King. Five million kroner were subscribed by the six million people of Sweden within six months.

Treatment is free for everyone unable to pay. This expense is borne by the local municipality and the state. By every possible means cancer patients are induced to attend the clinics, and the railway fares are paid. There is an elaborate system of records, and the follow-up, which in important cases reaches to twelve years, is so complete that but one per cent. of cases fail to return for observation.

The medical profession in Sweden has an exceptionally fine training, and post-graduate work in radio-therapy extends over four or five years. Dentists and nurses are carefully trained at the centres. There is an effective education of the public. In Stockholm alone the clinic has from 150 to 200 cases a day. There seems to be a complete collaboration between all medical, surgical and radio-therapeutic services, and it is asserted that all cancer cases receive the *treatment best suited* to the particular case. All practitioners have such confidence in the clinics that the majority of cancer cases are promptly sent there. In spite of these conditions there is the same complaint as elsewhere, that many cases come too late for successful treatment; but here, also, it is pointed out that the cured patient is the best educational argument.

In operable breast cases it is the custom to give a series of six high-voltage X-ray treatments in ten days and after a rest of four to six weeks, a further series of four such treatments in the week preceding operation. After operation, X-ray or radium treatment is given to the axilla but not to the breast area. This plan is varied according to the case and is said to give excellent results. In small fibroids in a young patient, operation is done. In large ones not readily operable, X-rays are used.

The director, Dr. Forssell, regards the dosage of radium as more constant and exact than that of X-rays, but both are highly valuable. Further discussion of this subject will be found elsewhere in this report.

Here, as elsewhere, the advice is given to centralize cancer work, to have one or two good centres with complete equipment, rather than a large number with inadequate facilities.

Estimates of the radium needed by a country were given as follows: Two grammes for each million of population, or for each 1,000 deaths from

cancer, or two to two and one-half grammes for each twenty-five beds for cancer.

Clinical Work, Radiumhemmet

The assistant director, Dr. Elis Berven, supervises the clinical work, aids in collaboration and carries on radium and X-ray treatment. Here the need for centralization of work was constantly repeated. It is thought a mistake to have too many centres. One main centre was advised for Ontario, with diagnostic centres in connexion with large hospitals having X-ray equipment and the establishment of centres where medical schools exist as soon as competent men are available.

The Radiumhemmet has had 28,000 cases for treatment since 1910. There is a day set for each type, e.g., breast, Wednesday; uterus, Thursday, etc. Treatment of cancer of the stomach by irradiation is avoided, as there are no facilities for this work at the Radiumhemmet. The assistant director is not impressed with the value of colloidal chemicals for the attack on cancer.

The practice in the use of radium at the Radiumhemmet is the opposite to that of the Fondation Curie in Paris. Here they use a high intensity for short period instead of a low intensity for a long period. Good results are said to be obtainable by either method.

About 300 cases are treated annually by the "bomb" of three grammes. The director and the assistant director are strongly impressed by the value of this method of treatment. Dr. Forssell says: "If you wish to be in the line of progress you will use teleradium treatment with a 'bomb'."

There are six X-ray machines using 150 to 170 kv. Seventy to eighty treatments are given daily, or 21,000 to 24,000 per year of 300 days. At the Radiumhemmet is shown the photo of the *first* patient in the world cured by the (weak) X-ray (1900).

Trained Radiological Personnel

The need of trained personnel is nowhere more highly emphasized than in Sweden. In addition to seven years of medical training, the students in the medical colleges have 20 lectures in the principles of X-ray diagnosis and treatment, and there is a two months' voluntary course of practical training, in which six lectures are given. Practically all students take the voluntary course.

The young doctor, wishing to pursue the method of irradiation, is taken on following a two-years' interneship; he has two years in the Radiumhemmet followed by two years as assistant in X-ray diagnosis and therapy in recognized centres. Finally, a fifth year is spent as radium and X-ray officer in one of the twenty-eight recognized provincial hospitals. This extensive post-graduate course is similar to that required by the Memorial Hospital, New York, and should form a guide to the requirements of proposed centres with us.

Education of dentists, nurses and the masses of the people, about cancer, is thoroughly carried out. Two and one-half million pamphlets entitled "What you can do and cannot do in cancer" are sent out each year. An almanac containing reliable information on cancer reaches every home. Systematic lectures are given. Care is taken not unduly to alarm the people.

The long experience of Dr. Forssell, the Director of the Radiumhemmet, his high reputation in irradiation treatment and the great confidence he has won from the public and the medical profession of Sweden invest his views with authority. At home and abroad his opinion on the subject of radio-therapy commands the highest respect.

DENMARK

In Denmark, the combating of cancer is a national movement, the funds for the fine modern Radiumstation, directed by Dr. Jens Juul, in Copenhagen, were contributed by the Danish people. This institution is managed by the "National Anti-Cancer Association" with a State grant of aid. In addition there are two other radium-treatment centres, viz., at Aarhus and Odense. X-ray treatment of malignant tumours is given in a number of hospitals throughout the country. There is active co-operation of all services in treatment, and great care is taken with the records of patients. No patient is lost sight of. It is recognized that if, as in Sweden, patients could be given a cost-free journey to the Radiumstation, the results would be much improved.

The country possesses about six grammes of radium. Both element and emanation are used, and the Copenhagen station has two high-voltage X-ray machines of the type seen in Frankfort. There are a pathologic-anatomical laboratory, a physical laboratory and one for experimental research.

In Copenhagen, the great Finsen Hospital and the Radiumstation are in the same grounds, with the same board of directors but with independent financial arrangements. The Finsen Institute is used for treatment of lupus, heart disease and surgical tuberculosis by artificial sunlight and for the study of light on living organisms. Large numbers of cases are treated.

It is said that Denmark has the highest mortality from cancer of all European countries. But the Danish people are well organized and the medical profession well-trained to cope with the malady.

CHAPTER TWO

PREVALENCE OF CANCER, INCLUDING ITS AETIOLOGY, DISTRIBUTION AND CHARACTER

THE PREVALENCE OF CANCER

The term cancer in reality covers a group of allied diseases and is used in the same sense in which we use the term infectious disease to apply to a number of separate infective processes. Under cancer are included two main groups of tumours, viz., the sarcomas and carcinomas. These again are variously subdivided, different bases of classification being given by different authorities as will be evident to anyone consulting the standard text-books on pathology.

Cancer is widespread and the evidence seems conclusive that it is increasing over the whole world. In the mortality returns of nearly all countries it has displaced tuberculosis from its position as the second greatest cause of death, the premier place being maintained by the heart diseases. Statistics over the past thirty years show in most countries a steadily falling tuberculosis death-rate, and a steadily rising cancer death-rate. It is possible that a substantial portion of the mortality of cancer may in modern times have been uncovered by the improvement in the records of death, by the more skilful diagnosis of physicians and by the increase in the life of man, but notwithstanding all these, the facts seem to indicate that the incidence of the disease, if we judge by the mortality rate, is on the increase. The view that cancer is largely confined to the civilized races no longer holds. There is evidence that if we consider the poorer opportunity for complete diagnosis and the fewer persons of advanced age, the incidence of cancer among aboriginals is quite as high as it is among civilized people.

The figures indicating the prevalence of cancer have for convenience been relegated to Appendix A, but it will be of interest briefly to consider some facts in respect to the situation in Ontario and other parts of Canada.

The Registrar-General's reports for Ontario bring into prominence the alarming increase in cancer mortality.

Thus in 1914 one finds that the recorded cancer rate was 69.6 deaths per 100,000 of population; in 1919 this rate had increased to 75.5; in 1929 to 104; and in 1930 to 109.5. In a population of approximately 3,500,000 there were 3,635 deaths in 1930.

The increase in cancer mortality is general all over Canada as may be seen by reference to the statistics in the Appendix. In 1930 there were in Canada 9,263 deaths recorded from cancer, the aggregate death-rate being 93 per 100,000 population.

The newer sections of the country, such as the provinces of Alberta, Manitoba and Saskatchewan, with a population of younger age, have the lower rates.

The records for England and Wales since 1847 show a similar increase. In 1847-50 the death-rate was 27.4 per 100,000. In 1930 this rate was 145.3.

In the United States of America, similar increases are on record, especially in the older settled states. Thus Lombard (Rhode Island Medical Journal, August, 1929) gives statistics of cancer mortality in Massachusetts as follows:

In 1842	the	cancer	deaths	in	Massachusetts	were	13	per	100,000 population.
" 1860	"	"	"	"	"	"	26	"	100,000 "
" 1900	"	"	"	"	"	"	71	"	100,000 "
" 1928	"	"	"	"	"	"	129.8	"	100,000 "

Kaplan (Radiology, August, 1931) says that in New York City in 1910

the certified cancer deaths were 78 per 100,000 of population, while in 1930 these were 117 per 100,000 of population.

Increase in Cancer Incidence and Mortality

The increase in the number of cancer cases and deaths seems to be world-wide. There can, indeed, be no reasonable doubt that there is this actual increase. Partially, the increase may be accounted for by better diagnosis and thus more correct certification of cases, while with the increasing longevity due to public health measures more people live to reach the age at which cancer has its greatest incidence (viz., after forty years).

Incidence in Relation to Mortality

For every death in any one year it can be calculated that there are three sufferers from cancer. Since there were in 1930, 3,635 deaths, it is fair to assume that between 10,000 and 11,000 people suffered from cancer in that year in Ontario and these figures may be taken as expressing the present incidence of the disease.

Age and Sex Distribution of Cancer

While cancer may occur at any age, the greatest incidence of cancerous diseases is after forty. The sarcomas are distinctly more common in childhood and early adult life, but as this group makes up but five per cent. to eight per cent. of the total, the age distribution thereby is not materially affected.

So far as sex is concerned, figures show a slight predominance of female cases. The locale of the cancerous growths varies widely with the sexes. Males show a marked predominance of cases of cancer of skin, lips, tongue and throat, a less marked one in cancer of oesophagus, stomach and rectum, while these are more than counter-balanced in the female by cancers of the breast and uterus. Appendix A contains statistics showing the distribution as to site, sex and age.

Discussion of Nature and Causation of Cancer

The growths we class as cancer belong to the general group of tumours. Many definitions of tumours have been propounded, but that of the late Professor C. P. White is here given, viz.: "A tumour is a mass of cells, tissues or organs resembling those normally present but arranged atypically. It grows at the expense of the organism without at the same time subserving any useful function." From a clinical standpoint tumours are in turn divided into the benign and malignant groups. The benign tumours are composed of cells which in their characters approximate to those of some adult (fully developed) body tissue. Such growths tend to be circumscribed and slow growing and show no tendency to disseminate.

Malignant or cancerous tumours on the other hand are composed of cells and tissues imperfectly differentiated and with increased vegetative and proliferative activity on the part of their cells. Hence these growths show little or no tendency to be circumscribed; they grow rapidly as a rule, spread out into surrounding tissues and tend to develop metastases (secondary growths) elsewhere by way of the lymph channels or blood stream.

In their origin then, both benign and malignant tumours, arise from the ordinary tissue cells of the part affected. Rapid proliferation of the cell is char-

acteristic of cancer. It seems to be a local rebellion of cells against the established order seen in normal cells. So far, however, no real cause can be assigned for the setting up of proliferation on the part of the local cells. It is the general opinion of all those consulted (a) that cancer is not infective, that is, cancer is not due to the transfer of any virus from a cancer patient to those with whom such patient has been in contact; (b) that cancer is not related to diet, whether animal, vegetable, or mixed, or to either excess or deficiency of any one food; (c) that cancer is not hereditary. True it is that in certain families there is a definite increased incidence of cancer, but this means only that their tissue cells more readily give origin to cancers.

Another point of importance which emerges is that cancer in its early stages is a purely local disease and that, while in this stage, it is particularly amenable to treatment.

In the Bulletin of "The Cancer Hospital," Fulham Road, London, England, this statement appears: "There is no disease which people dread so much as cancer. Much of this fear will be dissipated when it is clearly understood that cancer is at first a local disease and that where still local and accessible it is always curable."

While thus cancer at first is local there is much to commend the opinion that some alteration in the general body metabolism is a factor of importance in permitting such local growth. Of many researches under way in different laboratories, the results obtained point strongly in this direction. Reference here need only be made to the work along these lines published by the Cancer Research Laboratories of the Graduate School of Medicine of the University of Pennsylvania.

Two factors which seem to have a definite bearing on the aetiology of cancer are (1) age, (2) exposure of local parts to irritation.

1. Age—While the sarcomas are commonly tumours developing during the actively growing period of life, viz., childhood and youth, these make up no more than five to eight per cent. of cancerous growths. The carcinomas on the other hand are essentially tumours of middle age and older people. It would seem that in many persons age robs the tissues of their capacity to withstand cancer.

2. There is no doubt that repeated irritation, especially when prolonged over months or years, may lead to the development of cancer. Thus cancer of the lower lip develops in certain pipe-smokers at the site on the lip where the pipe is held. Cancer of the tongue develops opposite a rough or jagged tooth, or on the site of a syphilitic plaque. Cancer of the cervix uteri grows at the site of a laceration at child-birth. Mule-spinners' cancer develops from repeated contact with shale oil used as a lubricant on weaving machines. Workers in aniline dyes seem to be susceptible to cancer of the bladder.

Into the mechanism of cancer development as a result of chronic irritation, it is not essential that we should enter. The theories in respect to this will be found with full discussion thereon in various standard text-books on pathology.

Lymph-stasis Theory of the Case of Cancer

In his recently published book, The Genesis of Cancer, 1931, Mr. Sampson Handley advances the theory that lymphatic obstruction is the underlying cause

of cancer. He says: "Any given consequence, such as cancer, springs from a chain of previous events stretching back to infinity and not from a single cause. But if among these events one can be detected which for a given consequence is very frequently present, and has never been proved absent, the clue to the problem of causation has been obtained and this event may be provisionally and loosely spoken of as the cause. In this sense I am bold enough to claim that *lymphatic obstruction* is the cause of cancer, though the labours of generations may be required to trace the intermediate steps. The evidence for this view is so substantial that it may claim to rank not as a hypothesis, but as an established theory—that is to say, as the solvent and unifier of all the relevant facts hitherto observed and the guide to future research on the subject. It has been raised to the rank of a theory by successive waves of evidence, coming in like a tide from independent observers and referring to distinct varieties of carcinomas, but all bearing testimony to the genetic relationship of papilloma or adenoma and carcinoma. The lymph-stasis theory of the genesis of cancer denies neither the infective nor the irritation theories. It reduces them in rank and absorbs them in a larger generalization. It denies the existence of any one specific cancer organism or parasite and asserts that the carcinogenic action of irritants upon the epithelium is exerted indirectly through the obstructive lymphangitis they set up in the lymphatic vessels of the sub-epithelial connective tissue."

As remarked by *The Lancet*: "It is for his work on the surgical or therapeutic side of cancer that the name of Sampson Handley will be lastingly remembered since by his classical researches on the paths of dissemination, he placed the surgical treatment of cancer upon a more scientific foundation—a foundation which is not likely to be shaken until we dispense with mechanical methods of destroying malignant growths."

Precancerous Conditions

In addition to the true cancer and benign tumours, there are cell processes which may precede true cancer and which are known as precancerous conditions. These precancerous reactions of tissue cells appear to be due to the influence of some external irritant or of some internal stimulus. Some of these growths result in cancer, the cancer developing from such primary local cell overgrowth. Thus it appears that there is a stage in the life history of certain cancers when the growth, while a departure from the normal, is not actually cancer. Examples of this are seen in the pearly appearance of the lip in smokers, in the white spots on the tongue or inside the cheek, or in the scaly accumulations of epidermis on the faces of elderly persons. These are not cancers; they are precancerous conditions which may, and frequently do, become cancerous. Early observation of and attention to precancerous conditions are most important in the prevention of cancer.

CHAPTER THREE

Section I

TREATMENT OF CANCER

TREATMENT OF CANCER

The factors which must be considered in the treatment of cancerous growths are (*a*) the site of the growth, (*b*) the type of cancer, (*c*) its stage of growth, and (*d*) the resources available for treatment.

(*a*) We may roughly define the sites of growth as accessible and non-accessible. Accessible growths comprise growths appearing on skin, lip, tongue, breast, cervix and body of the uterus. Non-accessible or poorly accessible applies to such growths as those along the digestive tube from pharynx to rectum, also to growths in the liver, pancreas, kidneys, lungs, mediastinum, brain and bones. Site, too, is an important factor in determining the diagnosis of cancer; as the more accessible and visible it is the quicker it is of recognition. The effects and limitations of treatment can be better gauged in accessible areas.

(*b*) The type of cancer is important in determining its relative malignancy. Some forms of cancer are very malignant and even their early recognition and treatment may not succeed in saving the patient. Others are much less malignant and thus afford more scope for treatment. For the purpose of diagnosis and of determining both the type of growth and its relative malignancy, it is a common practice in accessible areas to remove a fragment of the growth for microscopical examination as to its histological structure. This practice will usually determine these characteristics. Some authorities question the use of biopsy, but most are agreed that its value far outweighs any possible risks.

(*c*) The earlier a cancer growth is recognized, the more likely it is to be purely local and amenable to treatment. Hence early recognition of cancer is of the greatest importance to both patient and doctor. Figures show that at the present time only from twenty to twenty-five per cent. of cancer cases seek relief at a time at which cure is possible. Francis Carter Wood in March, 1931, Radiology, says: "Only twenty per cent. of cases of carcinoma admitted to hospital are operable. That is, eighty per cent. are, when seen, incurable by means of surgery. A few of these may be cured by irradiation."

Why the delay in recognition and seeking relief? This question has been discussed by various authorities, but for our purposes it suffices to quote from Lombard's conclusions in cancer studies in Massachusetts (Commonhealth, vol. 16, No. 14, 1929).

1. The median delay between first symptoms and first consultation with a physician for individuals with cancer coming to the state-aided cancer clinics in Massachusetts is six and one-half months.

2. Males delay longer than females, except for skin cancers.

3. The greatest delay is in cases of cancer of the skin and the shortest delay is among patients having cancer of the uterus.

4. Thinking that the condition was a minor malady is the largest single cause of delay. Among males this reason is considerably greater than among females.

5. The greatest single cause of delay between consultation with a physician and the institution of adequate treatment is because of poor advice on the part of the attending physician.

6. Forty-five per cent. of cancer patients have a median delay of six months after consulting a physician before adequate treatment is instituted, while fifty-five per cent. received treatment within a short time following diagnosis.

We note from the above that in the State of Massachusetts, Lombard finds the patient's own delay in consulting a physician is the main factor in cases presenting themselves at a time when tumour growth is in its earlier (and more curable) stages; that physicians in forty-five per cent. of cases materially add to the delay by their non-recognition of the actual conditions present. Thus both patients and physicians need education which will lead to the earlier recognition of cancer.

(*d*) The chief resources in the treatment of cancer are:
Surgery and
Radio-therapy { Radium / X-rays of high voltage }

Of these resources, surgery has long held the field, and surgery remains the most potent agent of treatment in cancer of the stomach, of the intestines, the fundus of the uterus, and other abdominal organs, though this field is being somewhat invaded by irradiation either as an active or as an auxiliary treatment. It is still the best resource in cancer of the larynx and oesophagus, but in these fields also, radium is taking a part. In treatment of cancer of the breast, surgery holds chief place but here again radium and X-rays are widely used in auxiliary treatment.

In cancers of the surface of the body, the lips, buccal cavity, the jaws and throat, and the uterine cervix, radium and X-rays afford very satisfactory results, especially if cases are seen early, a requisite that decidedly enhances the opportunity of cure by any method. It appears therefore that for the largest number of cancers of the human body, surgery is still the method of choice, but it is equally apparent that both radium and X-rays are powerful and effective methods of treatment, and that facilities for treatment of cases should include all three.

In addition to these methods there is a variety of therapeutic measures such as various serums and tissue extracts and the use of colloidal lead or arsenic. The results from these are, so far, too indecisive as seriously to enter into competition with the proven results of the well-known above-mentioned triad. These agents are dealt with more specifically elsewhere.

Surgery

In this report it is unnecessary to dilate upon the value of surgical treatment. Surgery since the days of the immortal Lister has shown an extraordinary development and some of the most prominent surgeons are of the opinion that its limits as a therapeutic measure have almost been reached. Surgery still holds the premier place in cancer treatment; the surgeon has reached an astonishingly high degree of skill; he is confident of himself, and it will be only by a discovery of newer, more exact, and simpler methods that he will be superseded.

The limited space in this report given to the consideration of the surgical treatment of cancer, fails to indicate the immense value of surgery as a therapeutic agent in malignant growths. The surgical treatment of cancer is so well known, both within and without the profession, that it seems out of place to say any more, than that in our present state of knowledge it is still the line of approach in the majority of cases.

Opinion of the value of early surgical measures in cancers is given by Lord Moynihan, one of the most distinguished of British surgeons, as follows:

"No better illustration of the value of early surgical interference in cases, for example, of cancer of the breast could be given than the statistics published three years ago by our Ministry of Health. Very briefly, it was found that when the operation for cancer of this organ was performed in the early stage of the disease, 90.1 per cent. of women were alive and well ten years after operation, whereas if the disease was very advanced, 94.4 per cent. were dead within this period. The nature of the disease was the same, the operation was the same; the stage of the disease made all the difference. It is true to say that every single case of cancer where the disease is accessible to the surgeon is curable in the early stage, for cancer is at first a local disease. It is quite obvious, therefore, that the future success of surgery very largely depends upon the education of the public in these matters and of a clear recognition of the fact that their only fear should be the fear of delay."

Radio-therapy

Radium, in the treatment of cancer, is used in two forms, first as a salt of the element, mainly radium bromide, or sulphate, which in appearance resembles white pepper, and second, in a solution of the salt from which an emanation or gas called radon is produced. The dose in each form can be accurately measured and is usually referred to as so many milligramme hours or millicurie hours of radium.

For use in treatment the radium salt is put up in needles and other containers. In this form it is inserted into or about the growth or is attached to moulds made of wax or sawdust (such as Columbia paste) and other applicators, and thus applied to the growth. Heavy doses, designated teleradium, are given in the form of a "bomb" or pack containing from one to four grammes of radium. Radon is used mainly in the form of glass or gold "seeds," which are inserted into the growth. The advantages and disadvantages of the respective uses of these two forms of irradiation are discussed in Appendix D.

The effect of radium element, of the emanation and of high-voltage X-rays, is much the same, and preference for one or the other is chiefly a matter of convenience, accessibility of the growth, and personal experience of the operator. For the treatment of tumours the hard or gamma rays are used, the softer rays being cut off by a filter of lead, platinum or other metal. The reason why these rays, in appropriate dose, destroy cancer cells, and at the same time have a minimum effect upon normal cells of the body, is largely because the cancer cells are in a constant state of division and are, consequently, more sensitive to the rays than normal cells. In addition to this, the rays are believed to have a stimulating effect upon the surrounding tissues, which contributes to their resistance against cancer.

The gamma rays are the ones used for irradiation. The container absorbs all the alpha rays, and the beta are screened off by 0.5 of platinum or other metal. This will ensure pure gamma irradiation. The absorption of alpha and beta rays is qualitative and does not vary with the intensity of the source and for protection the thickness of screen must correspond with the increase of element source. Thus, for 0.5 grammes of radium 6 centimetres of lead are required, while with 2 grammes, 12 centimetres are necessary.

The "Bomb."

The Eighth Report of the British Empire Cancer Campaign expresses caution in the use of a bomb of four grammes of radium such as that in use at the Westminster Hospital Annex. It is said to be dangerous, producing

rapid dimunition of the blood cells after from twenty-five to thirty hours' treatment. A small decrease in the red cells is produced, but the white cell count falls from 7,000 to 3,000 or less, the lymphocytes being particularly affected. On the other hand, small exposures over a long period cause a definite increase in the white cell count. The damage is not irreparable; a period of rest is followed by a return to normal. Experience at the Memorial Hospital, New York, at the Villejuif Hospital, Paris, and at the Radiumhemmet, Stockholm, is favourable to the use of the "bomb."

The Times of February 9th, 1932, carries a letter signed by Mr. Stanford Cade and five other medical men protesting against the withdrawal of the "bomb" from use in the treatment of cancer cases and urging the immediate appointment of a committee of enquiry to consider how best to advance radiotherapy. The letter points out that certain types of cancer are better treated by the bomb than by any other means. This view and the opinions quoted on this subject elsewhere in the report, indicate that the value or otherwise of the use of large amounts of radium in the treatment of cancer, is by no means settled. Time and further experience alone will definitely solve this problem.

Sources of Radium

The chief source of radium at present is the Belgian Congo. There are deposits of uranium in Czechoslovakia. Discoveries of radium-bearing pitchblende have been made along the east shore of Great Bear Lake and northeastward to Coronation Gulf in the Canadian Northwest, 800 miles from railhead.

Great Bear Lake lies on the Arctic Circle east of the Mackenzie River. The pitchblende deposits are present in an area centreing around Echo Bay on the south shore of the lake. The geological features of the area have been studied by Kidd of the Geological Survey of Canada (Canadian Mining Journal, January, 1932), by Knight (Canadian Mining Journal, October, 19th 1930), and others. These, as well as Spence of the Canadian Mines Department, furnish authentic descriptions of the location and extent of the discovery. According to Spence this is "the most important mineral discovery in many years. Two veins have been proved over a combined length of 2,000 feet, and pitchblende has been found at several points over a distance of two miles. Samples of the ore show one gramme of radium to between six and one-half and thirteen tons of ore." Referring to the suggested monopoly in radium, he said, "that if there were any such monopoly it would soon be broken by Canadian output." (Press report.)

Referring to these deposits, Labine (Northern Miner) says: "The pitchblende vein varied in width from one-half an inch to eighteen inches of massive ore; in pit No. 6, open cut thirty-five feet long, the pitchblende averaged ten inches wide for this length. A sample cut across twelve inches in the south end of this open cut assayed 1,210 ounces, and a further channel sample cut in the centre of the open cut assayed 503.35 ounces, across a width of sixty-six inches. The deposits of pitchblende are associated with rich deposits of silver and other minerals and the results for last year's operations have demonstrated beyond any doubt, that a large tonnage of rich pitchblende ore is available for the production of radium."

Regarding the deposits in Ontario, Burrows, Geologist to the Department of Mines, says:

"The property of the Ontario Radium Corporation is situated a few miles east of Wilberforce village in Haliburton County. The geological occurrence

is that of a series of pegmatitic dikes cutting granite gneiss, and located on a high ridge south of the railway. Several pits and trenches have been cut into the dikes and gneiss along the trend of the deposit. The radium-bearing mineral uraninite occurs in nodular and crystal form as a constituent of the dikes or with the later minerals that have followed the intrusion of the pegmatites. Uraninite in small pea-like inclusions and up to masses of several pounds have been found over several hundred feet along the strike. The uraninite occurs with various minerals of the dikes, like feldspar, hornblende and magnetite, and also with apatite, fluorite and calcite. The dark-coloured purple fluorite is reported to be radio-active, being called radium-fluorite. Owing to the irregular occurrence of the uraninite, it is impossible to sample the rock by ordinary channels, and the best method is by mill tests. A shipment of thirty-six tons sent to the Ottawa Laboratory gave concentrates of uraninite and other heavy minerals and was satisfactory. A small mining plant was installed and a tunnel driven southerly to intersect the several dikes known on the surface and uraninite was found in a number of these. One surface showing above the tunnel was particularly good. A small concentrating plant has been erected and concentrates are to be made. I am not aware what further treatment would be given the concentrates. This consists of an elaborate chemical process to obtain radium salts. The deposit is attractive and requires pioneer work and experimentation, and the directors deserve praise for the effort. The deposit is large and the work now being done should show just what percentage of radium-bearing minerals can be recovered."

A gramme of radium is now worth about $70,000 and there is only about one pound available in all the world's hospitals. New York City has about sixteen grammes. There are about sixteen grammes in use in Canada. At present prices about $200,000,000 worth is urgently needed throughout the world for the war on cancer. In view of the prospects of gaining an adequate supply from Canadian sources, the purchase of large quantities by the government of Ontario requires most careful consideration.

Both X-rays and radium in excessive doses are very dangerous. Those in charge of treatment must use the greatest care in prescribing the dosage used and in adopting safeguards necessary for the protection of both workers and patients. The use of irradiation, whether from X-rays or radium, demands prolonged experience and meticulous care. It is a form of treatment that can best be successfully and safely carried out in an institution established for the purpose, in the hands of skilled operators; it is not one for the general practitioner. Everywhere this fact was impressed upon the Commission. The rays of radium and the X-rays are invisible, potent agents for good when properly used; they are dangerous in the hands of persons unskilled in their use.

X-rays.

X-rays have great penetrative power, but with the voltages used at present, not so great as that of the gamma rays of radium.

Up to recent date the main field of the use of X-rays has been diagnosis, particularly in connexion with fractures, dislocations and other affections of the bones and joints, in the diagnosis of pulmonary conditions, and in ulcerative and obstructive conditions of the abdominal cavity. The X-rays are also used for therapeutic purposes, especially for certain superficial skin cancers and for such non-malignant conditions as goitre.

In treatment of cancer by X-rays a high voltage is used. The rays must be strong enough to penetrate to the deeper parts. For the purpose of deep

X-ray therapy the common voltage is from 180,000 to 220,000. Apparatus has been developed to produce a million volts or more, but such strengths are not yet in practical use.

The deep X-rays are similar in their effect to the gamma rays of radium in the treatment of cancer. Some operators use X-rays alone, others use them in selected areas such as the abdominal cavity where the parts are more or less inaccessible to the use of radium. Both X-rays and radium are used as auxiliaries in the treatment of growths. They may be used before operation or after operation.

There is a difference of opinion in respect to the dosage of X-rays and radium. Some operators employ a large dose over a short period, others a moderate dose over a long period, with, apparently, similar results.

The X-rays, while remarkable agents for good, are none the less extremely dangerous both to operator and patient unless the most rigid precautions are taken. The rooms containing the high-voltage machines are carefully protected by leaded walls, and operators carry on their observations of the patients under treatment through leaded glass windows.

A more complete discussion of these agents appears in Appendix D.

Section II

USES AND LIMITATIONS OF RADIO-THERAPY

USES AND LIMITATIONS OF RADIO-THERAPHY

The use of radio-therapy is not confined to the treatment of malignant diseases alone. In certain regions of the body radium, and in others X-rays, are among the most effective agents in the treatment of cancer. Radium in addition is of the greatest value in a large group of non-malignant diseases, while in a few it is almost a specific. The action of radium on living tissue may briefly be summarized as follows: (Richards, Canadian Public Health Journal, July and August, 1931).

1. Immediately following a mild dose of radium or X-rays on living tissues there is an increase in cell activity, i.e., a stage of stimulation.

2. If the dose be prolonged either in intensity or time, there is a stage of arrest of cell activity. This may be described as the stage of over-stimulation.

3. If this dose also be exceeded either in time or intensity, there is a stage of destruction and degeneration of the cells.

Among the non-malignant affections which respond to radio-therapy are: naevi of the skin where the results of radium are eminently satisfactory, angiomata, where the implantation of radon seeds is much superior to other methods of treatment, and chronic myeloid leukaemia for which radium is applied over the spleen and X-rays to the marrow-forming bones. The patient with chronic lymphoid leukaemia frequently gains much benefit from X-ray and radium treatment. In pure exophthalmic goitre or thyroid toxicity without adenoma, the percentage of clinical cures from X-rays and radium is between seventy and eighty per cent. In toxic adenoma the toxicity is usually reduced. In the disturbances of the menstrual function in younger subjects X-rays frequently restore the normal balance, while in bleeding at the menopause radium is a most effective method of treatment. The bleeding from fibroids of the uterus may readily be controlled by radium. The smaller fibroids usually disappear completely under this treatment, and the larger greatly benefit. The keloids of scar-tissue respond to the use of both radium and X-rays but in pigmented moles radium is not a suitable treatment as there appears to be a definite risk of inciting malignancy by its use.

Among malignant growths treatment of rodent ulcer by radium is usually effective so long as the disease is limited to the skin. Epitheliomata of the skin require a heavier dose of radium, but with suitable dosage the vast majority, if taken early, are cured. In the lip, tongue, buccal cavity, tonsils, and upper part of the pharynx a high percentage of cases are susceptible of cure. In cancer of the oesophagus and stomach the results of irradiation are disappointing and the same may be said of cancer of the colon and rectum.

In cancer of the body of the uterus the results of treatment (see Burnham, Forssell and others) compare favourably with those of surgery. The irradiation treatment of cancer of the uterine cervix is probably better understood and on the whole more successful than in any other of the malignant fields. This subject is further discussed under Results of Treatment.

In cancer of the breast early and small tumours may be removed by radium. In pre-operative treatment, radium alone or in combination with X-rays is of much value. As a post-operative measure X-rays are the more commonly used in prophylaxis; the use of radium is more effective *in recurrences* of the disease.

In cancer of the bladder and prostate the use of irradiation is still in the period of transition. In cancers of the thyroid, which are fairly radio-sensitive, the results justify the use of radium packs and high-voltage X-rays.

In sarcomata there are two extremes in the type of cell. The lympho-sarcoma is extremely sensitive to radio-therapy while osteogenic sarcoma is very resistant. The former frequently disappears with astonishing rapidity after radio-therapy but permanent cures are difficult of attainment owing to its tendency to rapid dissemination throughout the body.

In the osteogenic type no cures are reported. Mediastinal sarcoma and "Hodgkin's" disease often disappear under the influence of radium or high-voltage X-rays and many of these results are permanent. (Richards.)

With the advance in knowledge of the capabilities of radiation therapy, with greater experience in its use, and with the possible employment of still higher voltages of the X-rays, the field of treatment by radio-therapy, even now very extensive, may reach much wider proportions.

In conclusion it may be said that up to the present *no cancer cure* has proved of definite value except surgery, high-voltage X-rays and radium. (Kaplan, American Journal of Cancer, January, 1932.)

Section III

CONDITIONS NECESSARY FOR CARRYING OUT SATISFACTORY RADIO-THERAPY IN CANCER

CONDITIONS NECESSARY FOR CARRYING OUT SATISFACTORY RADIO-THERAPY IN CANCER

The views of the highest authorities on this subject coincide to a remarkable degree. They are nowhere better expressed than in the words of Dr. Gösta Forssell, Director of the Radiumhemmet. He asks the question: "Why has radio-therapy, and particularly radium-therapy, in most parts of the world produced such poor results, that the capacity of radio-therapy to effect a lasting cure in malignant tumours has been generally doubted?" and goes on to answer it as follows:

"The chief cause of this is, in my opinion, the splitting up of radio-therapy which has occurred in most places. Radium has been distributed for use in various clinics without any proper control as to whether sufficient experience existed there, either in respect to radium or Roentgen therapy, and without sufficient resources always being available to carry through radio-therapy in a satisfactory manner. The treatment, and the following up of the results of the treatment by Roentgen rays in one and the same case, have also not infrequently been split up amongst many hands, so that the same medical man has not looked after the radio-therapy and been responsible for the issue.

Until quite recently the arrangements for the radio-therapy of tumours were not properly organized. Cancer patients in need of radio-therapy were sent, either to radiological institutions which were best equipped for radio-therapy, or to surgical clinics which were earlier the only clinics able to afford any help in cancer. The radiologists, however, had often not a great deal of experience in the clinical pathology of tumours and did not possess their own clinics for the study of radio-therapy of tumours. The surgeons, on the other hand, had often neither sufficient knowledge and training in radio-therapy, nor the necessary resources for carrying out the same.

In the combined surgical-radiological treatment of tumours the surgical interference has been looked upon as of main importance, and radium or Roentgen treatment as a more or less negligible adjunct. In reality radio-therapy is the chief treatment in all those cases of cancer where the tumour cannot be removed with safety by a cut in sound tissue. The skill in its use decides the patient's fate. Surgery is in these cases only an auxiliary, although often a very important one. This circumstance has not been clearly understood hitherto, and until it is, the combined surgical-radiological treatment is doomed to failure.

To this must be added another important circumstance. A surgeon, who only deals with radio-therapy as a side-line, is mostly, as a matter of course, chiefly interested in surgery, and, possibly, in radium application during operation. All the rest of radio-therapy of malignant tumours, comprising about seventy-five per cent. of the entire scope of radio-therapy, is of minor interest to him.

The surgical clinics have their special task, to take care of the patients who need surgical treatment. They want for this purpose all their accommodation. Experience also goes to prove that the patient must often be discharged from the surgical clinic immediately after healing has occurred after an operation, without regard to the requirements of radio-therapy, for he then encumbers a bed which is so necessary for other patients. Even during the periods of radiological treatment prior to operation, it is difficult to find accommodation for the patient in the busy surgical clinics. It has, therefore, frequently been

impossible to carry through effective radio-therapy, or during or after treatment to supervise the patient in a satisfactory manner.

Experience in Sweden, as elsewhere has gone to prove that only at well-equipped special clinics has success been gained in improving and developing this method of treatment, so as to reach results which actively complete surgery, and in certain spheres extend beyond its scope.

In order to obtain perfect treatment at a radio-therapeutic clinic for cancer patients, it is necessary that it should be in charge of specially qualified medical officers, who have undergone a long training and devoted themselves to radio-therapy, and have plenty of time not only for the current work but also for scientific studies. This is all the more necessary since the techniques of radio-therapy are in course of experiment, so that this treatment in several directions may be said to be in an early stage of development. In order to be able to gain sufficient experience in respect of cancerous diseases and the special technicalities of treatment of various forms of tumours, and different localizations of tumours a radio-therapeutic section should have beds for a comparatively large number of patients.

Well-equipped, expensive laboratories are necessary for Roentgen and radium treatment. Large quantities of radium are necessary to enable tele-radium treatment. Thus, for a department of twenty-five beds, according to the experience gained at the Radium Home, a quantity of at least two grammes of radium is required if the resources of radium-therapy are to be fully utilized. In order to gain the utmost benefit from this expensive and precious medicine it is, on the other hand, necessary for the number of beds at the radio-therapeutic clinic to be so large that the radium can be in constant use.

For radio-therapy a comparatively large and specially trained nursing staff is required: nurses, technical assistants and servants. In the training of the staff and in organization, regard must be taken not only to the special technicalities of treatment and nursing, but also to the protective techniques and the care and superintendence of the radium.

The work must be organized in consideration of the risks taken by the staff, and the staff must be large enough to allow of sufficient leisure and a proper distribution of work. In fact, irradiation not only frequently extends over a fairly long period, during which the healing must be watched, because the minutest remnant of the disease spells risk of a recurrence, but also the treatment cannot on account of the course of the disease be finally judged until after the lapse of a great length of time. By reason of these circumstances, supervision, observance and control of the patients during and after the period of treatment are a *sine qua non* at an institution for radio-therapy of cancer. The work of supervision calls for a special organization, with its own staff and its own premises.

For scientific control of Roentgen and radium irradiation at a radio-therapeutic clinic, a radio-physical section is imperative under the supervision of a physicist, and for the diagnosis of tumours and the scientific elaboration of the observations made, the clinic requires a pathological laboratory under the supervision of a tumour pathologist.

Organized co-operation must take place between the surgical clinic and its special departments on the one hand and the radio-therapeutic clinic on the other.

As a rule, according to our experience, it is best for radical operations and such auxiliary interferences as call for a great deal of surgical skill, to be entirely performed at the surgical clinic. Minor operations and most of the endo-

thermic operations, can, and should, on the other hand, be performed at the radio-therapeutic clinic. It is, therefore, necessary for one or more of the medical officers at the latter to be trained in surgery, as well as to have undergone special training in radio-therapy.

A medical man who devotes his services to the radio-therapeutic clinic must, however, forsake general surgery, because radio-therapy necessarily occupies all his time.

At the Radium Home co-operation with our foremost surgeons has taken place, to the entire satisfaction of all parties.

The need of this co-operation between surgery and radio-therapy entails, however, the consequence that the radio-therapeutic clinics must be attached to big clinical hospitals, in the most intimately possible conjunction with the surgical clinic and its special departments.

On account of the vast number of cancer patients gathering at the radio-therapeutic clinic, the surgical clinic will simultaneously develop into a special clinic for tumour surgery, and the surgeons will acquire a great deal of experience in operations combined with radio-therapy and its activity. At the same time the surgical clinics will get rid of cancer patients during the period when the latter are not in need of special surgical treatment."

Section IV

RESULTS OF TREATMENT OF CANCER

RESULTS OF TREATMENT

Brief reference to results of the treatment of cancer appears here and there throughout the foregoing account of the Commission's investigations.

A more extended, but necessarily limited statement follows:

In the reports of the various national radium centres published by the Medical Research Council (1931) the results of radio-therapy are summarized as follows:

Cancer of the Breast

At the Middlesex Hospital the best results were obtained with radium used at a distance of six centimetres. In the early stages cancer of the breast appears to be usually responsive to suitably placed radium therapy. Death of patients is due to distant metatases. In almost all cases there has been a great local improvement or in disappearance of the primary tumour.

Cancer of the Uterus

In cancer of the cervix the Stockholm or Paris techniques are used. At the London Hospital high-voltage X-rays are used only for recurrences. Radium is used in cancer of the body of the uterus. Of forty-one patients treated since 1925 thirty-one are now living.

Cancer of the Mouth, Nose and Throat

At the Birmingham General Hospital treatment has been given to 122 patients, with forty-three clinical cures, eight improved, seventeen not improved, and fifty-four deaths. Clinical cures have been obtained in the following percentages: tongue (anterior 2/3), thirty-two; (posterior 2/3), twenty-four; floor of mouth, fifteen; cheek and lip, fifty-two. In the throat the most hopeful sphere for radium proved to be extensive septic, inoperable growths of the pharynx and hypopharynx, which tend to invade the larynx. Radon was preferable to radium on account of the retching and discomfort due to the strings which are attached to the needles in the use of radium. Cancer of the oesophagus has proved disappointing, but one case showed improvement after eight months.

Cancer of Rectum

At the Birmingham General Hospital, fifty cases have been treated, a preliminary colostomy being usual. Unsatisfactory results are attributed to the fact that rectal cancer is more resistant than squamous epitheliomata of the mouth. Attention is drawn to the possibility of inoperable cases becoming operable as a result of radium therapy.

Cancer of the Bladder

All the cases were advanced and while none were cured, symptoms were relieved for from six to eighteen months. It was found that a large haemorrhage, however severe, could be controlled by a large dose of radiation of the malignant mass.

Brain Tumours

At the Royal Infirmary, Manchester, five cases of hemispherical glioma were treated by external radiation. Two of the patients are in good health and able to work, two are dead, and one is a complete invalid. The gliomas appear to be especially radio-sensitive.

Sarcoma and Lympho-sarcoma

Good results were obtained in fifty per cent. of cases of spindle-cell sarcoma, in forty-one per cent. of round cell sarcoma, and in twenty-five and one-half per cent of lympho-sarcoma.

Burnham, quoted by Richards, pages 390, 391, Canadian Public Health Journal, July and August, 1931, gives the comparative results of treatment of cancer of the uterus by various methods as follows:
Body of the Uterus—

Cases treated by operation alone—
Total cases.....11
Living and well after five years.....50 per cent.

One case lost sight of which, if excluded, would leave the five-year cures sixty per cent.

Cases treated by radium alone—

Total cases.....46
Living and well after five years.....55 per cent.

Excluding those known to have died of other causes than cancer, the cure rate is sixty-nine per cent. If the cases dying of other causes than cancer and with no evidence of cancer are placed in the cured list, the *cure rate* would be seventy-four per cent.

Cases treated by radium and operation—
Total cases.....11
Living and well after four years.....55.5 per cent.
Excluding one case lost sight of.....62.5 per cent.

In summing up these results Burnham says:

In operable cancers of the body of the uterus, radiation offers a method of treatment comparable to the best surgical treatment in its permanent results. It obviates to a large measure at least primary mortality and is applicable to a large number of patients who are bad surgical risks. Radiation offers a possibility of cure in a considerable percentage of inoperable and recurrent cancers of the body of the uterus.

Cervix of the Uterus—Heyman.

From the standpoint of radiation therapy in this disease, there have been two schools, one making use of radium alone and a second, chiefly in Germany, using deep X-ray therapy alone. Finally, as was to be expected, these have been combined, and in a recent article by Heyman of the Radiumhemmett, Stockholm, a comparison of results is given from which the relative value of the use of radium alone or the combined treatment may be drawn.

These figures are as follows: Inoperable cases, radium only, 9.4 per cent. of cures; combined treatment, 17.6 per cent. of cures; operable cases,

radium only, 42.8 per cent. of cures; combined treatment, 52.1 per cent. of cures. It will thus be seen that the addition of high-voltage X-ray therapy to the use of radium in these cases is responsible for approximately a ten per cent. increase in cures, and this is the method which is at present being followed as a routine in the Radiumhemmett. It also may be taken to indicate that the possibility of cure in a reasonably early carcinoma of the cervix is fifty-two per cent., while if the disease is unrecognized until a later stage this falls off very rapidly and is about seventeen per cent., a further plea, if any were necessary, for early, accurate diagnosis and adequate treatment of all cases of carcinoma of the cervix.

In the Cardiff, Wales, clinic, the following results were obtained in 153 cases of cancer, treated since 1922:

	Total cases treated	Alive	Percentage alive
First Treatment:			
Over 5 years ago	25	0	0
" 4 " "	43	3	6.9
" 3 " "	72	5	6.9
" 2 " "	98	8	8.1
" 1 " "	117	14	12.1
Less than 1 year ago	153	40	26.5

A comparison between the results of surgery and radium may be gained from the following tables:

RADICAL SURGICAL TREATMENT OF CANCER OF CERVIX

Clinic	Total number of cases seen	Total number of cases operated upon	Primary Mortality	Relative cures	Absolute cures
			per cent.	per cent.	per cent.
Johns Hopkins Hospital	387	290	14.23	26.6	13.7
Wertheim	690	345	18	42.4	18.3
Schweitzer	443	177	6.78	51.4	19.8
Petersen	380	60	26.6	40	6.6
Collected by Duncan, 1921	5,027	3,151	3.54	19.3	11.72
*Bonney	420	265	14.9	39.6	25

*Includes 21 cases lost sight of.

RADIUM TREATMENT OF CANCER OF CERVIX

Clinic	Total number of cases treated	Primary Mortality	Relative cures of operable cases	Absolute cures
			per cent.	per cent.
Radium Institute, Paris	450	.....	80.5	26.2
Radium Institute, London	350	.....	20	12.5
Women's Hospital, New York	196	2	.....	23.6
Memorial Hospital, New York	578	nil	41	18.5
Doderlein	755	6	43.6	14.3
Bumm	805	.....	28.3	15.27
Howard A. Kelly	500	nil	50 (31% border)	11
Radiumhemmet, Stockholm (Heyman)	737	1.19	All inoperable	23.1

At the Radium Institute, Villejuif, the following results accrued from the use of radium and X-rays:

STATISTICS—WICKHAM

	Cases treated	Deceased	Alive, not cured	Cured
1921	11	9	.....	2
1922	26	18	.....	8
1923	24	19	1	4
1924	31	21	2	8
1925	30	16	3	11
	122	83	6	33

Per cent. cures, 27.

The percentage of absolute cures obtained from the use of radium and surgery do not vary very greatly (twenty to twenty-five per cent.).

Eminent surgeons, such as Victor Bonney of the Middlesex Hospital, London, claim that more cases would be saved if all patients whose growths are removable were operated upon by an expert in gynaecology and the remainder treated by radium, than by the use of radium alone.

"On the other hand, the radiologists advance numerous arguments in favour of the radium treatment of carcinoma of the cervix uteri as opposed to the surgical treatment.

1. Statistics are on a par (certainly in no way inferior) with those following operation (hysterectomy).

2. The almost negligible mortality due to radium is contrasted with the operation mortality of the young gynecologist while he is perfecting his technique of Wertheim's operation.

3. The technique of hysterectomy has now reached its limit even in the most expert hands. To improve the surgical results a technique which aims at removal of more affected tissue must be devised. Since the present surgical mortality is due to the extensiveness of the operation, this is unlikely.

4. Radium treatment, however, is only in its infancy (first used in carcinoma of the cervix twenty-two years ago). The prospects of further development and consequent improvements in the technique are great.

5. In the length of time the patient is in hospital and the freedom from pain after its use radium has a great deal to commend it.

6. The psychical effect of a major operation (with its mortality rate) as opposed to treatment by radium acts adversely in regard to the patient reporting for treatment at an early stage of the disease.

7. In cases where for other reasons operation is contra-indicated, radium is the only method of treatment available, while as a palliative measure in advanced cases there is no treatment whatever which is so beneficial.

8. Finally, the further use of intraperitoneal radium or radium at a distance may with time show either to be a great adjuvant to present methods.

For these reasons, the radium workers claim that in cases of carcinoma, hysterectomy should be abandoned in favour of treatment by radiation."

—Porter.

Dr. John Fraser, Regius Professor of Clinical Surgery, University of Edinburgh, discusses (Newcastle Medical Journal, January 1931), the results of treatment in buccal cancer by (1) operation, (2) radiation, and (3) radiation combined with operation.

Operation. This class comprised sixty-eight cases and no radium or X-ray application was used. These cases were placed in two classes, (*a*) those without (forty-two cases), and (2) those with (twenty-six cases), glandular invasion. The results in these cases were as follows:

TABLE I

Total	Cured	Recurred	Died	Untraced
68	16 (23.5%)	31 (45.5%)	20 (29.4%)	1

Divided into the groups (*a*) without glandular invasion, and (*b*) with glandular invasion, the results were as follows:

TABLE II

	Total	Cured	Recurred	Died	Untraced
Gr. A	42	15. (35.7%)	17. (40.5%)	9. (21%)	1
Gr. B	26	1. (3.8%)	14. (53.8%)	11. (42.3%)	

The duration of the cure runs from 1½ to 10 years.

Radium Treatment

With respect to radium treatment Dr. Fraser goes on to say: "Neither case numbers nor time intervals are sufficient to make our figures of real value, but, as observers who have been interested in the subject for a considerable time, and as investigators who are groping from darkness into what I hope is a fuller light, our experience may be of interest, if not of real scientific value."

He divides his radium experience into two epochs, early and late.

The early epoch was characterized by treatment of the buccal lesion by the method of interstitial radiation, using a relatively small dose (350 to 1,000 milligramme hours), the glandular areas being treated by radical block dissection. The results were as follows:

TABLE III

SMALL DOSAGE GROUP—350-1,000 MILLIGRAMME HOURS

Interstitial Method

Healed	10%
No change	20%
Temporary relief followed by recurrence	40%
Local condition aggravated	30%

These local results gave great disappointment because of an insufficiency of dosage and of an error in the technique of administration. The later cases were dealt with by means of heavy dosage (5,000 to 10,000 milligramme hours), and the radiation secured by means of surface application. On this basis the group of figures in Table IV were obtained:

TABLE IV

Results of Treatment of Local Lesion

Surface radiation and heavy dosage (5,000-10,000 milligramme hours):	
Local lesion healed	86.6%
Local lesion *statu quo*	6.6%
Died during course of treatment	6.8%

A heavy surface dosage, with the minimum of damage and destruction to the part, appears to offer the best prospects of a satisfactory result.

Again Dr. Fraser says: "I believe it will ultimately be found that the degree of cell resistance is in relation to the amount of keratin which the cell contains; that full keratinization, with its associated cell nest formation, is a phase of cell change which is peculiarly resistant to radio-therapy."

He feels that the most satisfactory way of dealing with the lymphatic field is to submit it to a radical block dissection elimination. If this is out of the question, interstitial radiation, using a large dosage, is the proper procedure.

Comparing the results of the treatment of cancer obtained with radium alone, with surgery alone, and with the two in combination, Lord Moynihan (American Society for the Control of Cancer, July, 1931) says:

"The surgeon's knife in the most highly trained hands is an instrument of great delicacy, but it cannot always discriminate between healthy tissues and diseased tissues. Radium is an instrument of far greater delicacy, because its action is selective, that is to say, it acts differently upon the diseased and healthy tissues, killing the one and leaving the other. The difficulty of its application sometimes lies in obtaining access to the diseased parts when they are inside the body and in placing it in close relation to every particle or cancerous tissue where access has been obtained. Great advances have been made, and it is now true to say that certain mutilating operations have been virtually abolished, as, for instance, those concerned with the treatment of cancer in the mouth or on the tongue. The future of radium as a therapeutic agent might therefore appear to be assured.

Radium will gradually encroach more and more upon the field of surgery, but it can never entirely replace surgery since it is not everywhere applicable. Where radium is applicable, its effect will always depend upon early diagnosis of the disease, so that greater success can only follow upon greater readiness of patients to present themselves for examination and upon the increasing skill of the medical profession in diagnosing the disease. It is a fair claim to make that the results up to the present are encouraging, but in the treatment of cancer we must always take the long view and must seek to know what results are found not in a few months' time, but at the end of not less than five years.

The desire for methods other than those which authority advises is as ancient as time. The sufferers from cancer are still beguiled by ignorant quacks and are too often encouraged in their beliefs by fraudulent advertisements or by irresponsible journalists.

The future of surgery depends therefore not so much upon any advance in craftsmanship, for that is hardly possible, but in the making and cementing of alliances with auxiliary sciences and, perhaps above all, with the science too much neglected to-day, the science of biology. It depends in a large measure also upon the enlightenment of the public and upon their seeking advice in the early curable stages of diseases rather than in the late and incurable stages."

As an example of the results of surgery in cancer of the cervix of the uterus, the figures given by Mr. Victor Bonney (London), from his own cases are representative of the best type of surgical work. He says:

"Between 1907 and the end of December, 1927, I had, with an operability rate of sixty-three per cent., performed Wertheim's operation 351 times. There were fifty-three deaths due to the operation, an operative mortality of 15.1 per cent. Of the 298 patients who survived the operation, 139 have died of recurrence, thirteen have died of other diseases, thirty have been lost sight of, and I am still in touch with 116, of whom sixty-four have passed the five-year limit, and fifty-two have been operated on at periods less than five years ago. The number who survived five or more years after the operation is ninety-five, of whom sixty-four are still under supervision, eight died of recurrence more than five years after the operation, six died of other disease more than five years after the operation, and seventeen were lost sight of more than five years after the operation. Of these ninety-five patients, forty-three have survived the operation for more than ten years, one of whom has survived it twenty years."

(*International Conference on Cancer, London, 1928.*)

Respecting the future of radio-therapy, Professor Forssell (1929) says:

"Finally, we have reached the question of the future possibilities of the development of radio-therapy in the treatment of malignant tumours. It is then obvious that the development and progress of radio-therapy must be greatly restricted by the fact that, at least with the present technique, it is mainly a method of local treatment, whereas cancer, by reason of its nature, in a short space of time spreads throughout the body. Radio-therapy can, therefore, never become a universal agent or panacea in the treatment of cancer. Its healing capacity is restricted to tumours confined to limited localities, accessible for irradiation.

A vast field for the further development of radio-therapy is the combined surgical-radiological therapy. Here the task of radio-therapy is to reduce the size of the tumour and better, to limit the same from its surroundings by irradiation prior to operation, and also to weaken the vitality of the tumour, thus diminishing the risk of local re-implantation, or spreading of the tumour through the operative interference. Its further task is, after the operation, to attack any possibly remaining parts of the tumour and to sterilize the adjacent glandular region. In the further development and progress of combined therapy the possibility must, ultimately, be taken into consideration that the radiological healing process, which is called forth through the pre-operative irradiation, may produce increased resistance on the part of the organism against the cancer disease. An important condition for the development of the combined therapy, is organized co-operation between radio-therapy and surgery.

A *sine qua non* for the improvement and development of radio-therapy is finally, properly organized research and tuition in the field of radio-therapy in cancer and within the sphere of cancer biology. The only prospect of attaining this is, again, the establishment of radio-therapeutic clinics, equipped with laboratories for research and means for the same. These clinics must be arranged in conjunction with large hospitals, so that radio-therapy may be given an opportunity for constant and intimate co-operation with other practical and theoretical spheres of medicine. The sums which are nowadays being collected for the purchase of radium will be largely wasted, and unexpected disasters will occur, both for patients and for the staff, unless simultaneously

with the money for radium, money is also provided for the establishment of clinics perfectly equipped for radio-therapy. Radium is a very important agent in the struggle against cancer; but radium is unable to cure a patient. For the latter purpose it is absolutely necessary to have well-equipped and organized special clinics; and, chiefly, very able physicians, who possess the necessary skill, knowledge and experience, and who are willing to devote life and soul to radio-therapy."

THE RESULT OF COMBINED SURGICAL-RADIOLOGICAL TREATMENT OF CANCER OF THE BREAST IN THE CASES TREATED AT RADIUMHEMMET IN THE YEARS 1921-1923
(Observed 5-7 Years After the Treatment)

Treatment	Total No. of Cases Treated	Cases Alive and Free from Symptoms 5-7 Years	Cases Divided Up in Accordance with Steinthal's Classification							
			Group I		Group II		Group III		Group IV	
			Total	Free from Symptoms	Total	Free from Symptoms	Total	Free from Symptoms	Total	Free from Symptoms
Operation: +Post-oper. irradiation	75	22 = 29%	10	6	55	16	10	0	65	22 = 34%
Pre-oper. irradiation: +operation: +Post-oper. irradiation	45	18 = 40%	8	6	31	11	6	1	39	17 = 44%
Electro-endothermy: +Post-oper. irradiation	42	12 = 29%	2	2	14	6	26	4	16	8 = 50%
Total	162	52 = 32%	20 12%	14 = 70%	100 62%	33 = 33%	42 26%	5 = 12%	120	47 = 39%

PERCENTAGE OF FIVE-YEAR CURES BY SURGICAL TREATMENT OF CANCER OF THE BREAST IN SCANDINAVIA

	Authors					
	Dahlgren	Neander	Brattström	Nystrom	Siirala	Kalima
Percentage, five-year cures	15%	16.8%	25.5%	20–23%	18%	24%

FINAL RESULTS IN CANCER OF THE MOUTH
Total Number of Cases at the Radiumhemmet, 1916-1921

	1916-1925		1916-1923		1916-1921	
	No. of Cases	Free from Symptoms 1 Year or More	No. of Cases	Free from Symptoms 3 Years or More	No. of Cases	Free from Symptoms 5 Years or More
Radiological treatment only:						
Cases without glandular metastases	88	31 (35%)	78	26 (33%)	68	21 (31%)
Cases with glandular metastases	72	0 (0%)	58	0 (0%)	45	0 (0%)
Total	160	31 (19%)	136	26 (19%)	113	21 (18%)
Combined surgical and radiological treatment:						
Cases without glandular metastases	57	43 (75%)	36	29 (80%)	17	11 (65%)
Cases with glandular metastases	27	10 (37%)	20	7 (35%)	5	5 (40%)
Total	84	53 (63%)	56	36 (64%)	22	13 (60%)
Total	244	84 (34%)	192	62 (31%)	135	34 (25%)

The following tables indicate the comparative results of radiological and surgical treatment of malignancy in Sweden.

TABLE I—PERCENTAGE OF FIVE-YEAR CURES AFTER RADIOLOGICAL TREATMENT OF MALIGNANT TUMOURS IN CERTAIN LOCALITIES

ONLY RADIO-THERAPY

(Results Obtained at Radiumhemmet)

Cases Treated Between		Total Number of Cases	Cases Cured	
			Number	Percentage
1910-1915	Carcinoma cutis:			
	Total number of cases treated	207	142	69
	Operable cases without glandular metastases	182	142	78
1910-1917	Carcinoma labii:			
	Total number of cases treated	66	45	68
	Operable cases without glandular metastases	52	45	86
1916-1921	Carcinoma oris:			
	(Ca. linguae; ca. subling.; ca. mandib.; ca. buccae)			
	Total number of cases treated	113	21	18
	Cases without glandular metastases	68	21	31
	Operable primary tumours	29	16	55
	Local recurrences	19	4	21
	Inoperable primary tumours	20	1	5
	Ca. linguae without apparent metastases	11	6	60
1914-1923	Carcinoma cervicis uteri:			
	Total number of cases examined	790	163	20.6
	Total number of cases treated	737	163	21.1
	Operable and border-line cases	188	76	40.4
1913-1921	Carcinoma corporis uteri:			
	Total number of cases examined (all treated)	46	20	43.5
	Operable and border-line cases	25	15	60
1910-1922	Sarcomata:			
	Primary tumours	238	58	24
	Recurrences after operation	154	28	18

TABLE II—PERCENTAGE OF FIVE-YEAR CURES AFTER SURGICAL TREATMENT OF MALIGNANT TUMOURS IN CERTAIN LOCALITIES

RADICAL OPERATION

	Total Number of Cases	Cases Cured	
		Number	Percentage
Nystrom's Swedish Statistics, 1911-1912—			
Carcinoma cutis:			
Total number of cases treated	140	app. 90 max. 115	app. 65 max. 76
Carcinoma labii:			
Total number of cases treated	241	max. 149	max. 62
Cases without apparent metastases	149	max. 109	max. 73

TABLE II.—*Continued.*

	Total Number of Cases	Cases Cured	
		Number	Per-centage
Haggström's Swedish Statistics on Cases Treated, 1916-1921—			
Carcinoma oris:			
(Ca. linguae; ca. subling.; ca. mandib.; ca. buccae).			
Total number of cases treated	64	20	31
Ca. linguae without apparent metastases	22	9	41
Heyman's Collective Statistics, 1927—			
Carcinoma cervicis uteri:			
Total number of cases examined (from 20 clinics)	5,024	905	18
Total number of cases treated (from 24 clinics)	3,659	1,303	35.6
Carcinoma corporis uteri:			
Total number of cases examined (from 6 clinics)	318	136	42.8
Total number of cases treated (from 8 clinics)	323	190	58.8
Nystrom's Swedish Statistics, 1911-1912—			
Sarcomata:			
Total number of cases treated	317	max. 11	max. 35

TABLE III—RESULTS OF TREATMENT IN ALL CASES OF CARCINOMA OF CERVIX TREATED, 1914-27

RADIUMHEMMET, STOCKHOLM: PROFESSOR HEYMAN

SYMPTOM-FREE AFTER

Year	Number of Cases	½ Year	Percentage	¾ Year	Percentage	1 Year	Percentage	1½ Years	Percentage	2 Years	Percentage	3 Years	Percentage	4 Years	Percentage	5 Years	Percentage	6 Years	Percentage	7 Years	Percentage	8 Years	Percentage	9 Years	Percentage	10 Years	Percentage
1914	26	14	53.8	14	53.8	12	46.2	9	34.6	9	34.6	8	30.8	7	26.9	7	26.9	5	19.2	5	19.2	5	19.2	5	19.2	4	15.4
1915	40	22	55.0	21	52.5	15	37.5	15	35.5	14	35	13	32.5	13	32.5	13	32.5	12	30	10	25.0	10	25.0	10	25.0	9	22.5
1916	47	15	31.9	10	21.3	8	17.0	6	12.8	4	8.5	4	8.5	4	8.5	4	8.5	3	6.4	3	6.4	1	2.1	1	2.1	1	2.1
1917	63	34	53.9	23	36.5	20	31.7	14	22.2	13	20.6	10	15.9	10	15.9	9	14.3	8	12.7	8	12.7	8	12.7	8	12.7	7	11.1
1918	42	15	1.22	15	1.21	94	6.31	74	1.51	53	6.61	33	1.71	22	3.31	12	6.81	02	4.41	02	4.41	02	4.41	02	4.4.	..	....
1919	76	50	65.8	41	53.9	29	38.2	25	32.9	25	32.9	24	31.6	21	27.6	20	26.3	20	26.3	17	22.4	17	22.4	..	....	..	....
1920	96	53	55.2	48	50	40	41.7	32	33.4	31	32.3	29	30.2	28	29.2	26	27.1	25	26	24	25	..	....	..	....	..	....
1921	113	70	61.9	60	53.1	54	47.8	46	40.7	44	38.9	36	31.9	30	26.5	27	23.9	27	23.9	..	....	..	....	..	....	..	....
1922	132	61	46.2	54	40.9	50	37.9	43	32.6	40	30.3	34	25.8	29	22	28	20.4	..	....	..	....	..	....	..	....	..	....
1923	104	55	62.9	49	47.1	43	41.3	36	34.6	32	30.8	28	26.9	25	24	..	....	..	....	..	....	..	....	..	....	..	....
1924	148	86	58.1	75	50.7	69	46.6	58	39.2	50	33.8	44	29.7	..	....	..	....	..	....	..	....	..	....	..	....	..	....
1925	132	71	53.8	55	41.7	45	34.1	28	21.2	28	21.2	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....
1926	140	80	57.1	69	49.3	61	43.6	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....
1927	149	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....

The Eighth Report of the British Empire Cancer Campaign records the following results at the Westminster Hospital. There was a survival rate of eleven per cent. after five years in inoperable cancer of the tongue; of eighteen per cent. after four years, and of twenty-six per cent. after three years.

Regaud, referring to radio-therapy in cancer of the breast (Arch. Inst. du Radium du l'Universite de Paris 2, 421–442), says:

1. The cure of cancer of the breast by means of radiation is exceedingly difficult. A true cure can be estimated only after a period of ten to fifteen years.

2. The variation in the thickness of the breast tissues creates conditions which further complicate the problem of irradiation.

3. Every cancer of the breast must be examined and treated by a group of the various specialties (surgery, Roentgen rays and radium). Small tumours give favourable results by juxtacutaneous curietherapy (plastic moulds). Massive tumours in large breasts are best treated by diathermic amputation associated with pre- or post-operative irradiation (X-rays or radium). Cutaneous and subcutaneous manifestation, as well as supra-clavicular glandular metastases, respond well to juxtacutaneous curietherapy, while the axillary metastases, owing to the necessity of crossfiring, are irradiated more effectively by Roentgen rays. Post-operative irradiation is indicated in all cases where the surgical removal remains incomplete.

The results gained by Zuppinger and Schinz (October, 1931, Journal of Laryngology and Otology) in laryngeal and throat cases, were disappointing. Professor Schinz states that the history and course of malignant tumours of the pharynx form the darkest chapter in the struggle against cancer. He has no doubt that in the next five years the results will be infinitely better.

In a communication to the Academy of Medicine, Paris, January 19th, 1932, Professor H. Hartmann reviews the late results in 125 cases of gastrectomy for cancer of the stomach observed for periods up to twenty-seven years. Of the twenty-five patients who showed no sign of relapse all but one had been under observation since operation for periods varying from one to twenty-seven years. Seven others died from other causes at from three to nineteen years without any return of cancer. In thirteen cases death occurred at from two to thirteen years after operation, cause unknown. In eighty patients there was recurrence of cancer; thirty-one in the first year, thirty-five in the second, eight in the third, and six in the fourth year after operation. Altogether, thirty-nine (thirty-one per cent.) survived the operation three years or more. Professor Hartmann is inclined to put at twenty-nine or thirty per cent. the proportion of his patients for whom a cure could be claimed.

Reference to the remarkable results in advanced malignant disease, reported by Carter and Cromarty, Brandon, Manitoba, indicates the value of optimism even in apparently hopeless cases. A series of 14 cases of advanced cancer were treated by surgery, electro-coagulation, X-rays and radium, used either singly or in combination. The fourteen were all apparently in good health after an average of seven years following treatment. A history of each case is given with details of treatment. (Canadian Medical Association Journal, March 1932.)

CHAPTER FOUR

RESEARCH IN CANCER

RESEARCH IN CANCER

Research

In all the countries visited by the Commission, research forms an essential feature of the equipment in the fight against cancer. Cancer research is of two kinds, (1) clinical, which is concerned with the gross manifestations of the disease, its distribution, by site, age, sex, etc., and its therapy; (2) fundamental, which is concerned with the inherent biological characteristics of the disease such as its cause, pathology and vital reactions to various physical and chemical stimuli. Research workers in America, the British Isles and Europe, are exploring the physical, bio-chemical, histological, pathological and animal experimentation fields in the hope of solving the cancer problem. According to the annual report of the British Empire Cancer Campaign for 1931, more progress along these lines is now being made in a single year than in any ten-year period previously. Indeed, it is not too much to say that in certain of the investigations now under way we shall find methods leading to earlier and more accurate diagnosis of cancers in the internal organs as well as methods of promise for treatment along serological or chemo-therapeutic lines.

As to therapy we have the suggestive work of Lumsden (London Hospital), a summary of whose recent labour is also found in the British Empire Cancer Campaign, 1931 report, and who has shown that he can cure cancer in animals with his anti-cancer serum. Maisin at Louvain, and H. Cramer and Magat at Berlin, working with special tissue extracts, have shown a large measure of success in treatment of animal cancer and even some human cures. Blair Bell and his associates at Liverpool working with lead, especially organic preparations of the metal, have had much success with mice and rats and some human cures.

As bearing on cancer production and carcinogenic agents we note the work done at Manchester on mule spinners' cancer in relation to shale oils used as lubricants (Twort and others, see list of publications in 1930 report of Manchester Committee on Cancer). The work of Drs. Kennaway and Cook at the Cancer Hospital, Fulham Road, London, on the carcinogenic factors in tar and the production artificially of highly carcinogenic varieties of Anthracene are highly interesting and suggest that other agents may be similarly proven to be carcinogenic for human beings. (British Empire Cancer Campaign Annual Report, 1931.)

Along different lines is the work of Professor Otto Warburg of the Kaiser Wilhelm Institute for cell-physiology in Berlin, on the metabolism of cancer cells. Work along similar lines has been carried on by Dr. Ellice McDonald of Philadelphia and his associates.

A great deal of work is being done in many centres on both spontaneous cancer in mice and other animals and in induced and inoculated cancer in animals. These animals have provided a basis for the study of aetiology and of the bio-chemical alterations in the body. They have also been invaluable as test material for various treatments, such as testing X-ray and radium dosage, etc.

Along another line of research we have the growth in vitro of both cancerous and normal tissues and the opportunity thus provided of studying cell metabolism and of trying out effects of treatment in modifying, inhibiting or actually destroying such cell growth. Work done in cancer cell growth at the

Strangeways Research Laboratories in Cambridge, England, and at the Rockefeller Institute in New York, is particularly noticeable though similar work along these lines is done at many centres visited.

Murphy, of the Rockefeller Cancer Research Laboratory, New York, holds that in each tissue cell there is an activating growth factor, and also an inhibiting or retarding factor. He bases his recent experimental work on the theory that in cancer we are dealing with unbalanced tissue cell proliferation, while the cell proliferation of repair and of chronic inflammatory process is balanced. Thus, where injury to tissue structure occurs, cell growth is just stimulated to a sufficient extent to effect repair and when the breach is filled the retarding factor comes into play to cause cessation of cell growth. In tumours the activating factor continues to act and the inhibitors are deficient. Murphy claims that he has proof of the presence of these factors and has to some extent been able to separate them and to use extracts containing these factors experimentally for treatment of mouse cancer with considerable success. He finds the activating factor to be species specific while fortunately the inhibiting factor is not species specific so that if it can be separated and concentrated it would act as a growth inhibitor in cancers of other animals including man. There is much work yet to be done before there is any possibility of adapting this process to the treatment of cancer in human beings.

Dr. Ellice McDonald and his co-workers (of the Cancer Research Laboratories of the Graduate School of Medicine, University of Pennsylvania, Philadelphia) have confirmed the work of Warburg (Berlin) regarding the metabolism of the cells of cancer differing in certain bio-chemical characteristics from those of normal cells, e.g., in their utilization of glycogen.

McDonald refers to the association of cancer with alkalinity of the blood plasma, and points out, that, according to himself and Reding of Brussels, cancer is generally associated with a more alkaline pH* and with a diminution in the ionized calcium and even total calcium in the blood plasma. Moreover, in clinically effective treatment by X-rays and radium, there is a shift in the pH towards the relatively acid side of normal and the ionized calcium is increased in amount.

McDonald says: "It is not too much to hope that cancer cells can be restrained from division and if this is done, the cancer will lose the quality which characterizes it—its power of spreading in the tissue which depends upon multiplication by division."

He is strongly of the view that the control of cancer rests upon a chemical basis and that the chemical laboratory will be one of the great factors in the solution of the cancer problem.

In the consideration of the chemistry of cancer Dr. McDonald showed that the following facts must be accounted for:

(1) The rate of formation of lactic acid in cancer is 10-20 times that of normal, and the quality is inherited in succeeding generations of cancer cells.

(2) There is little or no accumulation of glycogen from lactic acid in the recovery phase.

(3) The presence of oxygen does not reduce the glycolysis in cancer tissue to the same degree as it does in normal tissue.

*pH is a symbol commonly used in expressing ion hydrogen concentration. It signifies the logarithm of the reciprocal of the hydrogen ion concentration expressed as a power of ten. In simpler terms it means the intensity of acidity or alkalinity of e.g.: the blood serum.

(4) The non-utilization of hexose diphosphate and the Robison ester is significant as normal tissues utilize these substances readily.

(5) There is a discrepancy between the rate of formation of lactic acid from glucose and methyl glyoxal in normal and cancer tissue which indicates that the mechanism of glycolysis is different.

(6) The pH of the blood of untreated cancer is relatively higher by an average of 18.2 per cent., which is significant of the increased glycolysis found by Warburg with increasing pH.

(7) The glucose concentration of the blood of cancer patients is relatively higher than normal by an average of twenty per cent.

(8) The more alkaline the blood the more rapidly the cancer advances and the shorter the duration of life.

(9) The greater the amount of the sugar in the blood the greater the number of mitoses or cell division which is a measure of the rate of growth of the tumour.

"A consideration of the experimental evidence leads one to the conclusion that there is, in cancer, a definite deficiency in the oxidation phase of carbohydrate metabolism as compared with normal conditions.

These facts hold good for transplanted animal tumours as well as for human cancers. The quality of high aerobic glycolysis is not a property of cancer tissue alone but is shared by embryonic (growing and dividing) tissue, by leucocytes and by the retinal tissue. For these tissues, however, there is a pure carbohydrate oxidation where the R.Q.—1, the respiratory quotient, is the ratio of oxygen to carbon dioxide, and in the case of cancer tissue, this value is never approached. Uninjured tissues will have a glycolysis after the cancer manner, but, with recovery from the injury, the normal metabolism is restored.

When the oxidative mechanism of a cell is injured, it may (1) die, (2) grow disordered, producing lactic acid anaerobically but when respiration becomes normal and aerobic glycolysis disappears, the cells are normal again, or (3) the cells grow and divide while their property of aerobic glycolysis persists and is handed on to successive generations of cells, as in the case of cancerous tumours. In cancer cells, aerobic glycolysis is inherited and, in other pathological cases, this is the result of injury and disappears with the recovery from the injury. In cancer cells, not only must the normal respiration be re-established, but it must be passed on to successive generations. Non-malignant cells die under anaerobic conditions, while malignant cells do not do so if enough glucose is added.

In cancer, therefore, there is a defect in the respiration, and this defect is connected with the oxidation of carbohydrates. The anaerobic and aerobic glycolysis of cancer cells is shared by other tissues, as the retina, but the respiratory quotient is unity. In the metabolism of cancers, the rate of growth and glycolysis resemble those of embryonic tissue, but the respiratory quotient is low, which differentiates their mechanism from that of the normal embryonic cells.

The nature of the injury to the oxidative processes in the cell is the fundamental metabolic problem in cancer and the cure of cancer will come through the production of a more oxidizing potential than the limiting oxidation-reduction potential necessary to cell division. The next step in cancer research is to find

out how the cancer cell can be transformed back, in its metabolism to the normal cell, to improve its oxidative capacity and to reduce its fermentative capacity. If the cells of a cancer can be reduced in their energy adaptations to the quality and amount of metabolism necessary for the maintenance of normal cells, then the cancer cells would be normal. In such a case, the cancer cells present in a tumour would not continue to divide and the cancer would not extend and be malignant any more. The growing cancer cells, are more susceptible to injury than the normal differentiated adult cells and so would gradually die and disappear. The cancer would be cured.

Like weeds in a field of grain, if the weeds can be prevented from spreading and growing, they become innocuous. But the job is to find out how to alter the metabolism so as to cause their destruction without destroying the healthy grain. The differences in reactions and metabolism of the cancer and the normal cells that have been found permits a more intelligent and scientific search for a cure. A chemical cure of cancer is only a matter of time and trouble. How much time and how much trouble remains to be seen."

Dr. McDonald also drew attention to the value of a bio-chemical laboratory in association with a cancer clinic to control and aid in the treatment of the patients by various chemical examinations, which are of value in regulating and directing the radiation treatment. Such a bio-chemical laboratory should be in direct association with the cancer clinic so that the workers would have their whole attention directed to this specific problem.

Dr. T. Lumsden, in the laboratories of the London Hospital, has shown that, by the injection of certain animals with cancer cells, he can develop anti-cancer substances against such cells in the serum of these animals. By fractional precipitation methods he can concentrate the anti-cancer substances into comparatively small bulk as compared with the original serum bulk. Injection of this anti-cancer serum will protect animals against inoculated cancer of the same type. Further, where animals have been inoculated and the resulting growth is only moderate in extent the serum will cause the disappearance of such growths. He has developed anti-bodies against human cancer but, as yet, has only done so on an experimental basis. There is a long step to be taken before such serums can be developed to a degree that they can be utilized for the actual treatment of human cancer. But now that it has been found possible to grow in vitro human cancer cells, there should be no lack of antigen; what will be needed is a large animal suitable for the development of a large bulk of serum. Such a possibility is by no means improbable or even remote and one hopes the day will arrive when this will be done.

Dr. Maisin of Louvain has been treating certain cancerous growths by the injection of an extract carrying the fat and lipoid contents of such organs as spleen, brain and thymus. These extracts are further fractionated and the lecithin-containing portion is utilized. (Details in May and June, 1931, issues of the Compte Rendus des Annales de la Societe de Biologie.)

Cramer and Magat of Berlin are employing certain chemicals in association with the use of radium and X-rays. It is claimed that colloidal solutions of certain aniline dyes and tuberculine improve the effect of X-rays. Tissue extracts similar to those in use at Louvain are employed.

Susman, Manchester, is working on the effect of the posterior lobe of the pituitary gland in cancer and claims that he has found that he can cause the disappearance of growths in mice by the use of an extract made from the gland.

Recently, Gye and Purdy of London have published a record of six years of research in an attempt to establish the virus transmission of cancer. In a criticism published in the Lancet (December, 1931) the following conclusion is reached:

"Evidence that the active component derived from the fowl is the factor responsible for the tissue specificity of the filtrates was not obtained, nor was any new evidence of non-cellular transmission of mammalian tumours adduced."

In 1931 Dr. F. G. Banting and Miss S. Cairns carried on experimental work with Rous chicken sarcoma. It was found that the serum of certain immune birds neutralized extracts of Rous sarcoma. Results indicated that this property is present only in the euglobulin fraction of the serum.

Summarizing the results of fundamental studies on the nature of the cancer process, Ewing (International Conference, 1928), says: "It is clear that the problem has been more exactly defined, new modes of approach have been opened up, and results of much importance have been obtained. I venture to think that the most promising field, and the deepest penetration into the secret, lies in the pursuit of growth-stimulating substances, produced by the cell, enabling it to obtain nutriment from unusual sources, maintaining growth in ever-increasing pace, until the process becomes irreversible and uncontrolllable malignant features are unfolded."

Research is the fundamental basis of all cancer work: the solution of the problem of cancer resides in the research laboratory.

CHAPTER FIVE

CANCER EDUCATION AND SOCIAL SERVICE ORGANIZATION

CANCER EDUCATION AND SOCIAL SERVICE ORGANIZATION

Francis Carter Wood (Radiology, March, 1931) says: "Only twenty per cent. of carcinomas admitted to hospital are operable." This means that eighty per cent. when first seen are incurable by means of surgery. Lombard gives similar facts and analyzes the reasons for delay in Massachusetts as has already been set out in the section of this report on treatment and in Appendix A.

Education of the public and of physicians then is vital to the success of a cancer campaign.

The cured (or recovered) patient is the best advertisement of a method of treatment and is as valuable for the doctor as for the public, since the average physician to-day looks on cancer as incurable. But time is an essential factor in this process, hence the necessity for other methods of approach.

Education of the Public

Such an educational programme always brings up the question of creating a fear of cancer. There may be someone who will develop this phobia, but as Dr. Bigelow of Massachusetts said, "If facts make people hysterical, they will be hysterical anyway." Such an educational programme should lay stress on the need of persons consulting their physicians regarding such points as unhealing sores, lumps, bleeding from any of the body orifices, protracted indigestion, loss of strength or unexplained ill-health. In this campaign there may be utilized various avenues of approach, as:

(*a*) Co-operation of the provincial health authorities and local boards of health in the spread of literature giving "Facts about Cancer" and emphasizing the need of its being detected early and given proper treatment.

(*b*) The provision of posters for display at health exhibitions and meetings should be made part of this co-operative effort.

(*c*) The use of newspaper advertisements, giving facts about cancer and urging people to consult their physicians regarding sores, lumps or unexplained symptoms. Advertisements should also make reference to treatment centres and explain how patients can reach these for diagnosis and treatment.

(*d*) The provision of lecturers to discuss facts about cancer and its treatment before service clubs, women's societies, etc.

Education of the Physician

(*a*) The average doctor in general practice will see fewer than half a dozen cases of cancer in the course of a year and these in scattered areas of the body, hence he can be excused for not being skilled in their diagnosis. The establishment of diagnostic clinics to which any suspicious case could be referred would materially aid the practitioner and would assure to the patient earlier diagnosis and an opportunity to obtain suitable and adequate treatment. Such diagnostic clinics would at first be part of the treatment centre but later could be established in all the larger city hospitals.

(*b*) The Canadian Medical Association arranges for post-graduate lectures before local medical societies. Each local society can have six such lectures annually. In this way speakers are provided to bring various phases of cancer diagnos s and therapy before local practitioners.

(*c*) The physician should brush up his knowledge of cancer, since if faced with a general educational programme for the public, he would in his community be looked upon as the local censor.

(*d*) Better training of medical students in cancer diagnosis and in types of therapy should be provided. The establishment of treatment centres in or in connection with the teaching hospitals of medical schools, would meet this requirement but it should be a proviso that such centres are made available for this educational work.

Social Service Organization—

One of the causes of delay in patients seeking treatment for conditions which prove to be cancerous, is the inability of the patient to withdraw himself or herself even temporarily from the home or labour circle. Lack of finances, fear of loss of employment, absence of any one to care for household or children are the major reasons for delay. These are the problems which must often be faced if the diseased person is to get early and adequate treatment.

In Ontario social service work so far has been organized in certain municipalities only. It is viewed primarily as a municipal problem. If this attitude is persisted in, it will mean that over a large area of the province in our towns and rural districts especially, no social service organization will exist to deal with these problems. Social service work should be part of the general scheme but must essentially be closely linked up with local municipal organizations for relief.

Such social service is essential too in the following up of many patients in order to secure their being checked as to effectiveness of treatment.

Of all the countries visited, Sweden has the best social service cancer organization and the closest co-operation between physicians and cancer treatment centres. It is not too much to hope that in time such an organization can be built up here.

CHAPTER SIX

CONCLUSIONS

CONCLUSIONS

The investigations of your Commission seem to warrant the following conclusions:

1. That while much is known about the predisposing or exciting causes of cancer, its actual cause is unknown. It is believed to be non-infectious, and while hereditary susceptibility may play a part in its incidence, there is no evidence that cancer in human beings is actually hereditary. There is no evidence that cancer is due to diet, either animal, vegetable or mixed, or to either excess or deficiency of any one food material.

2. That cancer arises from the normal cells of the body through some unknown cause from the stimulation to growth of these cells. It then grows by the multiplication of its own cells. When it becomes distributed to parts of the body other than its primary site, this is due to the transmission of cells from itself and conveyed by the circulating blood and lymph streams.

3. That while the cause of cancer is unknown, the chief predisposing conditions associated with it are age, and chronic irritation.

4. That cancer seems to be increasing even though the increase is accounted for in a large measure by the prolongation of life due to the spread of public health activities, by the better statistical records of the present day and by the advance in diagnostic methods.

5. That while the incidence of cancer seems to be lower in the primitive races, this circumstance is probably due to the fewer number of persons of advanced age, to the lack of opportunity for skilled diagnosis and to the incomplete records found among such people.

6. That everywhere the deplorable situation is found that most cases of cancer are seen too late to afford the best opportunity for successful treatment.

That early diagnosis of cancer is of vital importance is indicated by the following statements, viz.:

> Dr. Joseph Colt Bloodgood of Johns Hopkins Hospital has said that fully seventy-five per cent. of cases of cancer of the breast could be cured if diagnosed early and treated promptly and properly.
>
> Lord Moynihan points out that where operation for cancer of the breast was performed in the early stages of the disease, 90.1 per cent. of the women were alive and well at the end of ten years, whereas if the disease was well advanced, 94.4 per cent. were dead within this period.
>
> Dr. Cl. Regaud of the Fondation Curie, Paris, says: "Early and accurate diagnosis and prompt treatment determine the success in the whole war against cancer. The ultimate outcome is largely in the hands of the first physician who sees the case."

7. That there are many early signs of cancer, and of pre-cancerous conditions. If these were observed, and followed by prompt measures of prevention and treatment, the mortality from this disease would be greatly reduced.

Among these signs are: the unhealing sore on lip, tongue and face, in mouth or throat; bleeding from the lower bowel or other orifice of the body; the lump in the breast; the hoarseness from an affected larynx; the protracted indigestion in middle age, that fails to respond to the usual remedies.

8. That these facts indicate the urgent need for a wide-spread campaign of public health education, among undergraduates in medicine and dentistry, among nurses, teachers, and the general public. Such education should be given through the press, by lectures, pamphlets, the radio, and by every available means. Short post-graduate courses should be established for physicians in connexion with medical teaching centres. The public attitude of the fear of cancer should be replaced by the *fear of delay.*

9. That there is reasonable certainty that cancer is at first a local disease and that when local and accessible, it is particularly amenable to treatment. Knowledge of these facts should dispel much of the fear of cancer. Even in advanced cases cures have been obtained. The greatest obstacle to improved treatment of the disease is mental lethargy and lack of knowledge of its early signs on the part of its victims.

10. That through cancer, as through disease generally, there is an enormous economic loss to the country, a considerable proportion of which might be saved by timely measures of prevention.

11. That, since sickness is the *greatest cause of poverty,* all parties, governments, municipalities, and the public should co-operate in the prevention of cancer and other diseases. The history of the public health movement illustrates convincingly that many diseases may be prevented and that others may be exterminated. The economic loss resulting from disease may be reduced and, a matter of much higher importance, the comfort and life of mankind may be greatly extended.

12. That in the treatment of cancer, surgical measures still hold the first place, especially in breast cancer, cancers of the alimentary canal, and of other deep portions of the body.

13. That radium and X-rays, either singly or combined or in conjunction with surgery, are highly useful curative agents in cancer. They are also important palliative agents, relieving pain and prolonging life.

14. That in certain areas of the body such as the skin, the lips, tongue, mouth, throat, and the cervix of the uterus, radium and X-rays are most effective. Successful results in the use of these remedies depend upon their use in skilled hands and upon early diagnosis. Inadequate or unskilled first treatment by radio-therapy is liable to hasten the progress of the disease.

15. That the high value of irradiation by the use of radium and X-rays is apparent from the records seen in a large number of clinics. The Radiumhemmet, Stockholm, which has been longest in operation, shows records of permanent healings in 69 per cent. of all cases of skin cancer, in 68 per cent. lip cancer, in 55 per cent. of operable cases of cancer of the mouth without metastases, in operable and borderline cases of the cervix of the uterus, 40.4 per cent., in cancer of the body of the uterus, 43.5 per cent.

16. That it is apparent that radio-therapeutic treatment can successfully be carried out only under the direction of clinicians fully qualified in the use of radium and X-rays. In Sweden, a most extensive post-graduate course in this work is required of the surgeon before he is given charge of a treatment clinic.

17. That both radium and radon (radium emanation) are effective in treatment in certain areas of the body. Their respective uses are determined chiefly

by the accessibility of the growth, the convenience of treatment or the experience of the operator. Both methods of treatment should be provided. "No modern community," says Mr. Stanford Cade, of the Westminster Hospital, London, "can afford to be without radium."

18. That while the use of one to four grammes of radium for massive or intensive irradiation and with suitable and adequate screening, requires caution, experience at the State Institute for Malignant Disease, Buffalo, the Memorial Hospital, N.Y., the Westminster Hospital, London, the Fondation Curie in Paris, and the Radiumhemmet, Stockholm, seem to warrant further trial of the efficiency of this method of treatment.

19. That a number of investigations are in progress with a view to obtaining high-voltage equipment capable of providing X-radiation approximating in wave-lengths to the gamma rays of radium. The success that has already been obtained in these investigations would seem to warrant the view that X-radiation obtainable from such equipment might in the future, in part at least, be a substitute for the radiation obtainable from radium. The application of these high-voltage X-radiations in the treatment of cancer is still in the experimental stage.

20. That various authorities agree in estimating the quantity of radium required by any country as two grammes per million of population or two grammes for each one thousand deaths from cancer.

21. That since cancer treatment centres, when established, will only gradually work into a position where they will be treating the majority of cancer cases in the Province, there is no need to supply this amount of radium at once.

22. That there is a wide diversity of opinion in respect to the use of the term "Cancer" in association with centres for treatment. Radium and X-rays are used for many non-malignant affections as well as for cancer. Hence, in some quarters there is the fear that the use of the word "Cancer" may prevent patients from coming to a centre so designated. Such names as "Radiotherapeutic Centre, Institute or Clinic," "Radiological Centre, Institute or Clinic," or "Tumour Clinic" have been suggested. This should be a subject for careful consideration in the organization of centres.

23. That active-treatment centres should possess the best possible facilities for treatment. They should be associated with a large general hospital, so as to provide a wide variety of cases for treatment, and a trained and specialized staff. In this way would be afforded opportunity for the instruction of medical students and of those desiring post-graduate teaching in the field of radiotherapy.

24. That active-treatment centres should be designed for the curative and palliative treatment of cases. Provision, if necessary, should be made for the care of hopeless cases apart from these centres.

25. That at the outset, because of the difficulty of securing qualified personnel, the centres established in Ontario should be placed in the cities which have medical teaching facilities. There should be kept in view the future development of additional centres and of diagnostic clinics in large hospitals. Experience elsewhere indicates that the best results have been secured by limiting the number of treatment centres.

26. That adequate laboratory facilities should be provided or utilized for assistance in diagnosis and for study of the cause and cure of cancer. These facilities should include laboratories for physics, chemistry, pathology and bio-chemistry.

27. That cancer research, both of the clinical and fundamental type is urgently needed. Clinical research is concerned with the gross manifestations of the disease, its distribution by site, age, sex, etc., and its therapy. Fundamental research is concerned with the inherent biological characteristics of the disease such as its cause, pathology, and vital reactions to various physical and chemical stimuli.

28. That since the welfare of the cancer patient should be the first consideration, there must be in all active-treatment centres, close co-operation of all services, medical, surgical, laboratory and radio-therapeutic, which deal with this malady.

29. That such co-operation should be ensured by the appointment of a Commission or Commissioner, whose duty should comprise the custody and distribution of radium, the organization and supervision of centres, and particularly the securing of close co-operation of the therapeutic and other services in such centres.

30. That in the successful treatment and control of cancer, it is essential that every patient be closely followed up so that he or she may be induced to return for observation at regular intervals. For this purpose every centre should possess an active Social Service. The duties of a Social Service should include not only the keeping track of patients and bringing them to the treatment centre, but also the supervision of home conditions, and the securing for such cases of moral, and, if required, financial aid.

31. That in order to supplement the efforts of the Government in the control of cancer, and other preventable diseases, appeal should be made to private beneficence for financial aid, either for definite needs, such as a Cancer Institute, or for a *Foundation* for Public Health, the income from which would ensure a flexible fund for the advancement of public health.

32. That many investigators are engaged in experimentation seeking the cure of cancer along the lines of serums, tissue extracts and bio-chemical processes. All these methods are in the experimental stage, but there is ample basis for hope that from these or from similar investigations a cure will ultimately be found. The Commission advises that the Government, through its research department, should investigate any of these methods of treatment which give reasonable promise.

CHAPTER SEVEN

RECOMMENDATIONS

RECOMMENDATIONS

Your Commission is required by the terms of the Order-in-Council of its appointment to enquire into and report upon the following points. To each question is appended the appropriate answer.

1.—*The use of radium and X-rays for the treatment of the sick*

Your Commission is agreed that the use of radium and X-rays of suitable wave-lengths and intensity is of high value in the treatment of cancer in certain parts of the body, and also in the treatment of a large variety of non-malignant conditions.

2.—*The advisability of the Province securing a supply of radium for the above purpose*

Your Commission having in view the value of radium in the treatment of the sick, etc., as indicated by the statistics of cure, observed in all clinics, is unanimously of the opinion that, in the public interest, it is advisable that the Government purchase from time to time such quantity of radium as may satisfactorily meet the demand for treatment of cancer by this means.

3.—*The advisability of the Province establishing a radium emanation plant with the necessary laboratories, etc.*

Your Commission, having studied the use of radio-active emanation in the treatment of cancer, is of the opinion that it is a useful method of treatment for certain cases, and therefore advises that a plant for the production, standardization and supply of radon be established.

4.—*The advisability of establishing a Cancer Research Department*

Your Commission advises the establishment of Research and other necessary laboratories for the study of cancer.

5.—*The advisability of establishing a Cancer Institute*

For the purpose of securing skilled personnel and for the stimulation and guidance of research and in view of the world tendency towards setting up institutions for the attack on particular diseases, your Commission advises the establishment of such an organization either as a separate institute, or as a separate unit in a general hospital, but in any case in proximity to a general hospital and in association with the medical teaching body of a university. The functions of such an institute would comprise not only diagnosis and treatment, but also research, teaching and public health measures against cancer.

6.—*The advisability of establishing Cancer Clinics*

Your Commission recommends that it is advisable to organize a limited number of active-treatment centres and a larger number of diagnostic centres, but at the outset, owing to the difficulty of securing experienced and highly skilled personnel, your Commission advises that in Ontario no more than three such active-treatment centres should be organized, and that these should be associated with a teaching hospital of a university.

7.—*The advisability of adopting plans and methods of educating the public with respect to the prevention of cancer.*

Your Commission, aware of the lack of knowledge of the public in respect to the early signs of cancer, advises that an active campaign of education should

be instituted, and that the co-operation of doctors, nurses, dentists, teachers, the press, and the public, should be sought for this purpose.

8.—*And generally any matter or question arising out of the subjects referred to the Commission, and which in the judgment of the Commission calls for investigation and consideration.*

In its study, your Commission was constantly impressed by the view that cancer should be treated by *experts* in the various lines of diagnosis and therapy; by the need, in the interest of the patient, of close co-operation of all services of treatment; and by the desirability of concentrating treatment in a few first-class centres under careful supervision.

Your Commission advises that no centre be established until competent personnel for such centre is available, and in this connexion desires to emphasize the fact that in unskilled hands, such potent weapons as X-rays and radium may do more harm than good.

In view of the fact that certain amounts of radium in Ontario are privately owned, your Commission recommends that in case the owners of this radium desire to dispose of it, the Government should consider its purchase.

Your Commission advises that, in connexion with every centre, the most careful and exact records of cases be kept, and that a Social Service be maintained for the purpose of "following up" all patients.

Your Commission advises that a Commission or Commissioner should be appointed by the Government for the custody, control and distribution of its own radium, for the inauguration and supervision of active-treatment centres and diagnostic clinics; and for the purpose of securing close co-operation of all services in the treatment of cancer; and that such Commission or Commissioner be attached to the Ministry of Health.

All of which is respectfully submitted.

(Signed) H. J. CODY,
Chairman.
J. C. McLENNAN,
W. T. CONNELL,
ARTHUR R. FORD.

Dated at the Parliament Buildings, Toronto,
the 29th day of February, 1932.

CHAPTER EIGHT

Contents *Appendices*

APPENDIX A

STATISTICS OF CANCER MORTALITY

STATISTICS OF CANCER MORTALITY

Ontario	Germany
Canada	France
England and Wales	Bulgaria
Australia	Czechoslovakia
United States	Luxembourg
Denmark	Hungary
Holland	Italy
Switzerland	Scotland
Norway	Esthonia
Sweden	Spain
Russia	Portugal
Finland	India

While statistics are better compiled than at any former period they are, in respect to disease, very unreliable. They are particularly unreliable in respect to a disease like cancer, since many forms of the disease, especially those of the internal organs, are difficult to diagnose.

All statistics show that reported cancer deaths are increasing; the average age of people has also been increasing, owing to the lowered death-rate which is largely the result of public health activity. Obviously, every person saved from death in youth becomes a potential victim of cancer in later years, and consequently every improvement in public health indirectly leads to an increased cancer mortality. A high cancer rate is proportionate to the degree of control of preventable diseases. Countries with a good public health service have at the present time the highest cancer rates. Every advance in diagnosis, medical and hospital care, adds to the number of cancer records because this advance increases the number of persons of the cancer age.

Certificates of death, while vastly better than those of a generation ago, are frequently valueless. Many people have the mistaken idea that a death from tuberculosis, cancer, or mental derangement, is a disgrace, and extraordinary means are sometimes taken to prevent such a report. Doctors are frequently importuned to record something other than the truth. In certain countries, it is said, the family doctor rarely places a diagnosis of cancer on the death certificate. In some cases of cancer, the only diagnosis is that made at autopsy.

Whether or not there is a definite increase in cancer as a whole, it seems certain there is a real increase of cancer in persons of the cancer age.

The following are the recorded cancer statistics of various countries:

Cancer Mortality in Ontario

The Province of Ontario has an area of 407,000 square miles and a population of approximately 3,500,000, the larger proportion of which is contained in the older part of the Province north and west of the Great Lakes and St. Lawrence River. With the exception of Prince Edward Island and British Columbia, the recorded cancer rates of Ontario are the highest in Canada. The cases and rates for the different types of cancer for the years 1920–1930 inclusive are included in the following table:

	1920		1921		1922		1923		1924		1925	
Buccal cavity	117	4.0	98	3.5	94	3.1	134	4.4	162	5.2	142	4.6
Stomach	782	27.0	860	29.2	869	29.2	938	31.0	1,023	33.4	1,050	33.8
Peritoneum	396	13.6	391	13.0	438	14.7	428	14.1	462	15.0	481	15.5
Female genital organs	234	8.0	236	8.0	224	8.2	283	9.4	323	10.5	333	10.7
Breast	198	6.8	235	8.0	231	7.7	279	9.2	320	10.4	331	10.7
Skin	49	1.7	66	2.2	77	2.6	811	2.7	85	2.7	81	2.6
Other or unspecified	688	23.7	699	24.1	656	22.0	531	19.2	571	18.6	533	17.2
Total	2,464	85.2	2,585	88.1	2,609	87.5	2,724	90.0	2,946	96.2	2,951	95.1

	1926		1927		1928		1929		1930	
Buccal cavity	134	4.3	141	4.4	132	4.1	155	4.7	124	3.7
Stomach	1,111	35.4	1,115	34.9	1,205	37.3	1,139	34.8	1,200	36.2
Peritoneum	513	16.3	526	16.5	605	18.7	627	19.2	629	18.9
Female genital organs	353	11.2	348	10.9	337	10.4	355	10.8	400	12.3
Breast	307	9.8	310	9.8	344	10.7	333	10.2	415	12.5
Skin	88	2.8	75	2.3	72	2.2	75	2.3	87	2.6
Other or unspecified	610	19.4	662	20.8	746	23.1	718	22.0	780	23.5
Total	3,116	99.0	3,177	99.6	3,441	106.5	3,402	104.0	3,635	109.5

In 1929 cancer caused 3,402 deaths or thirty-nine less than in the preceding year, the rate per 100,000 of population being 104 or 1.1 points lower than that of 1928. The number of deaths in 1930 was 3,635, the rate being 109.5.

A comparison of increases in the rate for the years 1920–30 inclusive is given as follows:

1920	12.9
1921	4.9
1922	0.9
1923	4.4
1924	8.1
1925	0.0
1926	5.5
1927	1.7
1928	8.3
1929	1.1 decrease
1930	6.8 increase

Increases 1914–29

In 1914 the cancer rate was 69.6 per 100,000 of population; in 1918, 75.5; and in 1929, 104. Cancer of the buccal cavity underwent slight changes, but there was a material increase in cancer of the stomach from 22.8 in 1914 to 34.8 in 1929 and to 36.2 in 1930. Cancer of peritoneum and intestines increased from 9.8 in 1914 to 19.2 in 1929, but dropped to 18.9 in 1930. Cancer of the female genital organs increased from 5.2 in 1914 to 10.8 in 1929

and to 12.3 in 1930. Cancer of the breast increased from 4.5 to 9.2; of the skin from 0.99 to 2.3. Other causes, including unspecified ones, have remained practically stationary; the rate in 1914 was 20.5 and in 1930, 23.5. The total deaths for 1929 were 3,402 and in 1930, 3,635. During the last decade the rate increase of cancer for Ontario has been nearly 20.0 per 100,000 of population. Comparing the mean rate of the last decade with that of the preceding decade, there has been a relative increase in the cancer death-rate of 31 per cent.

In dealing with increases in cancer rates, it is of much greater importance to consider the increase for the different organs and parts of the body affected than to consider the disease as a single entity. The figures below are for the period 1920–30 inclusive.

(1) Cancer of buccal cavity:

Has increased from 82 deaths to 124 or from 2.8 to 3.7 per 100,000 of population.

(2) Cancer of the stomach:

Has increased from 623 deaths to 1,200 or from 21.9 to 36.2 per 100,000 of population.

(3) Cancer of the peritoneum:

Has increased from 305 deaths to 627 or from 10.7 to 18.9 per 100,000 of population.

(4) Cancer of the female genital organs:

Has increased from 181 deaths to 400 or from 6.3 to 12.3 per 100,000 of population.

(5) Cancer of the breast:

Has increased from 128 to 415 deaths or from 4.5 to 12.5 per 100,000 of population.

(6) Cancer of the skin:

Shows an increase in deaths from 58 to 87 or a rate increase from 2.0 to 2.6 per 100,000, while the other or unspecified deaths have dropped in the period from 805 to 780, the comparative rates being 28.3 and 23.5 per 100,000 of population.

Cancer in Males and Females

The following table for the year 1928 illustrates the number of cases and their distribution in males and females:

	Males	Females
Cancer of the buccal cavity	108	24
" " stomach and liver	644	561
" " peritoneum, intestines and rectum	284	321
" " female genital organs	...	337
" " breast	2	342
" " skin	43	29
" " other or unspecified organs	490	256
	1,571	1,870
		1,571
		3,441

This table shows how much more frequently cancer attacks the mouth of men than of women, the deaths being four and one-half times as many in men as compared with women. The difference is not so great in regard to cancer of stomach and liver, there being 644 deaths in men as compared with 561 in women. In the case of the peritoneum, intestines and rectum, there are 284 deaths in men as compared with 321 in women. Cancer of the genital organs takes a large toll of women, reaching 400 deaths in 1930. There are relatively fewer cases of cancer of this area in 1930. The skin cancers show a higher rate for men than for women, while the unspecified sites show 497 deaths in men as compared with 283 in women. This comparison is from the 3,635 deaths from cancer in Ontario in 1930, but the proportion as between organs will be found to vary very little from year to year.

Ontario

The following tables show the deaths from cancer in Ontario, compared with total deaths by age groups in males and females, 1925–1930 inclusive.

DEATHS FROM CANCER

Compared with Total Deaths—by Age Groups

1925

Age Groups	Total			Male			Female		
	All	Cancer	Per cent.	All	Cancer	Per cent.	All	Cancer	Per cent.
Under 5	6,970	1	.154	3,823	1	.03	3,142	3	.09
5–9	628	5	.08	371	2	.54	257	3	1.67
10–14	491	10	2.03	268	4	1.49	223	6	2.69
15–19	633	5	.79	348	3	.86	285	2	.72
20–24	801	10	1.25	377	4	1.06	424	6	1.41
25–29	839	23	2.74	395	5	1.27	444	18	4.05
30–34	859	45	5.24	399	15	3.75	460	30	6.52
35–39	966	69	7.30	481	18	3.73	485	51	10.52
40–44	1,103	116	10.54	547	30	5.48	556	86	15.45
45–49	1,226	200	16.03	638	59	9.26	588	141	23.66
50–54	1,409	256	18.17	718	95	13.24	691	161	13.29
55–59	1,752	313	17.80	938	127	13.50	814	186	12.86
60–64	2,305	408	17.70	1,203	200	16.61	1,102	208	18.85
65–69	2,889	476	16.40	1,553	234	15.07	1,333	242	18.62
70–74	3,168	400	12.65	1,642	217	13.22	1,526	183	11.99
75–79	3,038	311	10.24	1,548	165	11.65	1,490	146	9.80
80–84	2,490	189	7.59	1,200	97	8.08	1,290	92	7.13
85–89	1,570	83	5.29	742	33	4.45	828	50	6.02
90–	788	28	3.56	362	15	4.14	426	13	3.05
N.S.	35	.....	.....	25	.....	.....	10	.....	.....

DEATHS FROM CANCER—*Continued*

COMPARED WITH TOTAL DEATHS—BY AGE GROUPS

1926

Age Groups	TOTAL			MALE			FEMALE		
	All	Cancer	Per cent.	All	Cancer	Per cent.	All	Cancer	Per cent.
Under–5	6,783	15	.22	3,811	7	.02	2,977	8	.03
5–9	634	4	.64	340	4	1.18	294	.....	.....
10–14	496	6	1.21	277	4	1.44	219	2	.91
15–19	689	9	1.30	373	6	1.60	316	3	.63
20–24	758	12	1.58	359	4	1.11	399	8	2.00
25–29	782	16	2.05	377	8	2.12	405	8	1.97
30–35	863	38	4.39	373	9	2.41	489	29	5.93
35–39	1,109	62	5.58	568	27	4.74	541	55	10.16
40–44	1,168	130	11.12	628	41	6.53	540	89	16.47
45–49	1,385	229	16.52	721	88	12.20	664	141	21.24
50–54	1,537	259	16.85	807	94	11.19	730	165	22.59
55–59	1,881	335	17.80	964	133	14.55	917	202	21.80
60–64	2,558	396	15.47	1,344	180	13.37	1,214	216	10.37
65–69	3,076	475	15.45	1,638	251	15.31	1,438	224	15.58
70–74	3,476	420	12.08	1,852	208	11.22	1,624	212	13.05
75–79	3,421	368	10.76	1,774	178	9.98	1,647	190	11.60
80–84	2,747	199	7.25	1,343	106	7.87	1,399	93	6.57
85–89	1,684	95	5.04	778	41	5.27	906	54	5.96
90–	797	26	3.26	348	11	3.16	448	15	3.34
N.S.	61	2	.....	41	.....	.....	20	2	.....

1927

Age Groups	TOTAL			MALE			FEMALE		
	All	Cancer	Per cent.	All	Cancer	Per cent.	All	Cancer	Per cent.
Under–5	6,127	17	.08	3,421	10	.29	2,706	7	.03
5–9	656	7	.92	389	4	1.03	267	3	1.12
10–14	531	2	.38	298	1	.33	233	1	.43
15–19	616	7	1.14	306	4	1.31	310	3	.96
20–24	765	20	2.62	382	3	.78	383	7	1.82
25–29	853	21	2.46	429	10	2.33	424	11	2.59
30–34	854	59	6.91	398	22	5.54	456	37	8.12
35–39	1,101	74	6.73	548	22	4.00	553	52	9.40
40–44	1,154	137	11.88	582	51	8.77	572	86	15.03
45–49	1,416	209	14.75	742	62	8.36	674	147	21.80
50–54	1,525	267	17.50	828	100	12.06	697	167	23.95
55–59	1,965	372	18.93	1,109	181	16.30	856	191	22.30
60–64	2,451	449	18.31	1,295	204	15.60	1,156	245	21.18
65–69	3,186	479	15.05	1,695	234	13.80	1,491	245	16.44
70–74	3,289	400	12.16	1,821	212	11.64	1,468	188	12.80
75–79	3,280	345	10.52	1,698	186	10.95	1,582	159	10.05
80–84	2,561	216	9.56	1,268	113	8.90	1,293	103	7.96
85–89	1,580	77	4.87	690	28	4.06	890	49	5.51
90–	801	27	3.37	358	10	2.79	443	17	3.83
N.S.	64	2	3.12	48	1	.02	16	1	.62

DEATHS FROM CANCER—*Continued*

COMPARED WITH TOTAL DEATHS—BY AGE GROUPS

1928

Age Groups	TOTAL			MALE			FEMALE		
	All	Cancer	Percent.	All	Cancer	Percent.	All	Cancer	Percent.
Under–5	6,187	11	.18	3,435	3	.09	2,752	8	.29
5–9	640	10	1.53	368	3	.81	272	7	2.57
10–14	488	6	1.23	252	1	.39	236	5	2.11
15–19	724	8	1.10	403	4	.99	321	4	1.24
20–24	921	18	1.95	480	10	2.08	441	8	1.81
25–29	936	14	1.49	482	5	1.03	454	9	1.98
30–34	973	42	4.39	447	16	3.58	526	26	4.94
35–39	1,075	73	6.78	529	26	4.91	546	47	8.62
40–44	1,305	148	11.32	683	53	7.77	622	95	15.27
45–49	1,476	238	16.12	789	83	10.51	687	155	21.52
50–54	1,732	290	16.22	935	107	11.56	797	183	22.95
55–59	2,077	401	19.35	1,120	180	16.07	957	221	23.05
60–64	2,603	485	18.62	1,402	236	16.82	1,201	249	20.07
65–69	3,315	525	15.84	1,815	281	15.48	1,500	244	16.27
70–74	3,592	476	13.25	1,873	242	13.92	1,719	234	13.62
75–59	3,613	397	11.00	1,848	185	10.00	1,765	212	12.00
80–84	2,795	194	6.94	1,353	87	6.43	1,442	107	7.42
85–89	1,717	78	4.54	802	39	4.86	915	39	4.26
90–	890	25	2.81	393	9	2.29	503	16	3.18
N.S.	63	2	.03	48	1	.....	15	1	.....

1929

Age Groups	TOTAL			MALE			FEMALE		
	All	Cancer	Percent.	All	Cancer	Percent.	All	Cancer	Percent.
Under–5	6,726	18	.02	3,755	12	.03	2,971	6	.02
5–9	689	4	.58	377	1	.26	312	3	.96
10–14	508	7	.13	279	5	1.79	229	2	.87
15–19	772	12	1.55	453	6	1.32	319	6	1.88
20–24	904	10	1.10	479	8	1.67	425	2	.47
25–29	889	17	1.91	455	7	1.83	434	10	2.30
30–34	934	51	5.46	465	15	3.22	469	36	7.65
35–39	1,116	87	7.80	585	20	3.41	531	67	12.61
40–44	1,312	150	11.41	714	45	6.30	798	105	13.15
45–49	1,489	201	13.50	810	64	6.67	679	135	19.87
50–54	1,796	325	18.10	985	113	11.47	811	212	26.12
55–59	1,998	338	16.90	1,117	149	12.72	881	189	21.42
60–64	2,588	459	17.72	1,439	239	16.58	1,149	220	19.15
65–69	3,412	535	15.67	1,834	274	14.94	1,578	261	16.55
70–74	3,842	465	12.10	2,010	250	12.44	1,832	215	11.72
75–79	3,716	397	10.78	1,912	196	9.99	1,804	201	11.14
80–84	2,884	208	7.23	1,424	115	8.08	1,460	93	6.37
85–89	1,737	102	5.87	827	57	6.89	910	45	4.94
90–	765	15	2.96	321	5	1.56	444	10	2.25
N.S.	46	1	.22	40	1	.02	6	.....	.....

DEATHS FROM CANCER—*Continukd*

COMPARED WITH TOTAL DEATHS—BY AGE GROUPS

1930

Age Groups	TOTAL			MALE			FEMALE		
	All	Cancer	Percent.	All	Cancer	Percent.	All	Cancer	Percent.
Under 5	6,555	10	.14	3,685	5	.14	2,870	5	.17
5–9	689	1	.14	412	.....	.....	277	1	.36
10–14	482	4	.83	267	1	.37	215	3	1.39
15–19	759	5	.66	422	2	.47	337	3	.89
20–24	909	16	1.71	500	11	2.20	409	5	1.11
25–29	861	22	2.55	441	6	1.36	420	16	3.81
30–34	886	54	6.10	452	27	5.89	434	27	6.22
35–39	1,112	93	8.35	586	32	5.46	526	61	11.60
40–44	1,257	182	14.47	653	54	8.28	604	128	21.05
45–49	1,498	218	14.55	815	68	8.34	683	150	21.96
50–54	1,784	315	17.65	979	123	12.56	805	192	23.85
55–59	2,062	392	19.00	1,082	144	13.40	970	248	25.59
60–64	2,559	471	18.40	1,410	212	15.02	1,149	259	22.51
65–69	3,293	590	17.92	1,761	294	16.69	1,532	296	19.31
70–74	3,878	512	13.95	2,077	281	13.52	1,801	231	12.82
75–79	3,556	403	11.41	1,852	218	12.77	1,704	185	108.6
80–84	2,704	223	8.25	1,298	111	8.55	1,406	112	7.96
85–89	1,625	97	5.97	752	43	5.72	873	49	5.61
90 plus	832	31	3.75	362	12	3.31	470	19	4.04
N.S.	22	1	.45	21	.....	.....	1	1	.....

CANCER MORTALITY IN CANADA

The recorded mortality rates for the Provinces of Canada are:

	(Dominion Statistics) Deaths		Deaths per 100 M of population,
	1929	1930	1930
Prince Edward Island	87.2	106.6	92
Ontario	104.1	109.5	3,635
Nova Scotia	97.8	100.1	555
British Columbia	117.1	118.3	707
New Brunswick	94.0	86.8	368
Manitoba	90.0	89.5	602
Quebec	79.2	85.7	2,346
Alberta	70.0	73.0	482
Saskatchewan	58.8	54.4	480
ALL CANADA	88.7	93.3	9,267

The relatively low rates of Saskatchewan and Alberta are probably due to the fact that the mass of the population of these new provinces has not yet reached the cancer age. The 1921 census shows that of persons between the ages of fifty and seventy (the cancer ages) Saskatchewan had only 9.07 per cent., while Ontario had 16.93 per cent. The cancer death-rate bears a fairly definite relation to the percentage of the population living at the age of fifty. The older provinces, with more people of over fifty years, thus show a higher mortality.

For example:

	Cancer Death-rate 1921	Percentage of Population over 50 years of age, Census of 1921
Nova Scotia	93.9	17.99
Ontario	88.1	17.78
British Columbia	74.9	15.09
Manitoba	74.7	11.61
New Brunswick	71.9	16.50
Quebec	55.8	13.47
Alberta	47.9	10.43
Saskatchewan	38.4	9.28

As time progresses, with consequent increase of older persons, one may assume that the cancer rates of the newer areas will increase.

The death rates from cancer in the older countries of the world are among the highest. The increase in rates for England and Wales has been constant since 1847; those of most European countries are steadily climbing.

The death-rate of the Province of Quebec is 85.7 per 100,000 of population as compared with 109.5 (1930) in Ontario. Hoffman, who has studied the cancer situation in the Province of Quebec, says: "There are the strongest reasons for believing that the French-Canadian population is less liable to cancer than the population of British origin." But cancer in Quebec is increasing; the rate of 77.2 per 100,000 of population for 1929 was advanced to 85.7 in 1930.

Cancer Deaths in Canada

In 1929 cancer killed 8,793 persons in Canada, as compared with 7,770 from tuberculosis, the comparative figures for the Provinces being: (Dominion Bureau of Statistics, 1929.)

	Cancer	Tuber-culosis
Alberta	452	391
British Columbia	692	615
Manitoba	597	424
New Brunswick	394	379
Nova Scotia	538	519
Ontario	3,404	1,702
Quebec	2,131	3,286
Prince Edward Island	75	75
Saskatchewan	510	376
	8,793	7,770

In 1930 the total cancer mortality of Canada was 9,263, with an advance in the rate over that of 1929 from 88.2 to 93.3.

It will be observed from the foregoing table (1929) that the number of deaths from cancer in each of the Provinces exceeds that of tuberculosis, with the exception of the Province of Quebec, where tuberculosis kills 3,286 persons while cancer accounts for but 2,131.

As a rule the rates of mortality for cancer are higher in the cities and larger towns than in the rural areas, probably because there is a larger proportion of people of the cancer age in cities and towns. However, the rates for Montreal, Ottawa and Quebec are much below the general rate for cities, being 79.8, 86.4 and 64.3 respectively. It is probable that the considerable French population of these cities may account for the lower rates.

Primitive races in Canada

The recorded cancer mortality of the Indians of Canada, while considerable, is below the general rate. Dr. H. E. Young, the Provincial Officer of Health for B.C., in a return of Indian deaths for 1923, found that among 26,000 Indians of that Province there were 889 deaths from all causes, of which eleven or 1.2 per cent. were due to cancer. This would give a rate of twenty per 100,000 population.

The investigations made by the Chief Officer of Health for Ontario give an Indian cancer rate of 70.6. The following figures for the year 1920 were furnished by the various Indian agents, who invariably are the registrars of vital statistics for the Indian population:

	Number of Indians	Deaths from Cancer	Rate per 100,000
Ontario	13,130	9	68.5
Prince Edward Island	25	0	0
British Columbia	8,362	7	83.7
Quebec	6,268	4	63.8
Nova Scotia	736	1	135.9
Saskatchewan	4,180	2	47.8
Alberta	2,780	0	0
Yukon	0	0	0
New Brunswick	737	2	271.4
Manitoba	3,444	3	87.1
	39,662	28	70.6

In dealing with statistics of native races one must always allow for a considerable element of inaccuracy. Indians and other primitive races, particularly the women, are very reluctant to undergo a close examination by a white doctor. Doubtless much disease is hidden, and never discovered. The Indian is stoical; he bears pain rather than make his condition known. If civilized women conceal or neglect, as they often do, a lump in the breast, is it not likely that the primitive woman may err to a greater extent in this direction? On the other hand, the primitive races do not live to so great ages as do civilized people. There is less "Cancer age" among them.

Efforts for Control of Cancer in Canada

Outside the diffusion of knowledge respecting cancer by physicians, medical societies, and health departments, and the provision of surgical and radio-therapeutic treatment by the hospitals of larger cities, little effort has been made by Canada to control the disease. In 1930 the Legislature of Saskatchewan passed a Bill providing for a permanent Cancer Commission, which Commission has recommended that one and one-half grammes of radium be purchased by the Saskatchewan Government at a cost of $105,000 to $115,000, and that a radiological service be established which "for the present is *not* intended to be a free service."

There is a radiological service in connection with Montreal hospitals and a small quantity of radium has been provided through the combined efforts of the Quebec Government and private individuals.

Ontario possesses about two grammes of radium, the Toronto General Hospital having nearly a gramme. Individual physicians and other hospitals possess small amounts.

Cancer Mortality in England and Wales

(Annual Report of the Chief Medical Officer, 1929 and 1930)

The records of cancer in England and Wales date back to 1847, and as will be seen by the accompanying table, show a gradual increase from year to year, the rate for 1847–1850 being 27.4 per 100,000 of population, as compared with 145.3 for 1930.

RECORDED DEATHS PER 100,000 FROM CANCER IN ENGLAND AND WALES

1847–1930

1847-50	27.4	1911-15	105.5
1851-55	30.6	1916-20	118.2
1856-60	32.7	1921-25	126.9
1861-65	36.7	1921	121.5
1866-70	40.3	1922	122.9
1871-75	44.5	1923	126.7
1876-80	49.4	1924	129.7
1881-85	54.8	1925	133.6
1886-90	63.2	1926	136.2
1891-95	71.2	1927	137.6
1896-00	80.0	1928	142.5
1901-05	86.7	1929	143.7
1906-10	93.9	1930	145.3

While cancer has reached second place as a killing disease in Ontario, it occupies third place in this list and accounts for 10.7 per cent. of the total number of deaths. The number of deaths attributed to cancer in 1930 is 57,882, or as already pointed out, a death-rate per 100,000 of 145.3. The recorded rate has, roughly, doubled during the past 35–40 years.

There is a remarkable regularity in the contribution of certain organs year by year to the total cancer incidence, it being understood that the mortality can be regarded as a reliable indication of incidence. The proportional frequency for males and females separately, for the decade 1918–27, is given in the following tables:

ENGLAND AND WALES

PROPORTIONAL FREQUENCIES OF ALL SITES OF CANCER EXPRESSED AS RATES PER THOUSAND OF ALL DEATHS FROM CANCER, 1918-1927

MALES

Site	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Lip	13	13	13	13	12	11	10	12	10	11
Tongue	62	63	58	55	52	50	50	49	44	47
Mouth and Tonsil	27	28	28	29	26	29	29	28	30	29
Jaw	28	26	26	24	23	25	20	22	21	21
Pharynx	13	13	12	13	13	12	13	13	13	13
Oesophagus	66	70	66	70	70	68	68	70	66	62
Stomach	203	201	208	214	217	221	214	221	222	227
Liver and Gall Bladder	102	102	94	87	86	77	75	71	69	63
Mesentery and Peritoneum	7	5	5	6	6	5	7	5	5	4
Intestines	107	114	112	114	117	115	124	119	129	130
Rectum and Anus	102	102	107	105	102	107	105	107	107	104
Breast	2	1	2	2	2	2	2	2	2	2
Penis	11	10	10	9	10	6	8	6	7	6
Scrotum						3	3	2	3	3
Other Skin	25	27	25	26	24	26	25	24	24	24
Larynx	31	28	32	31	32	32	31	33	34	32
Lung and Pleura	14	14	16	17	20	18	21	21	24	27
Pancreas	17	18	21	21	24	25	26	25	26	30
Kidneys and Suprarenals	10	9	10	10	11	11	9	11	11	11
Bladder	34	32	33	29	30	29	31	31	30	30
Prostate	29	33	33	37	40	44	44	46	47	47
Testis	5	5	5	5	5	4	5	4	4	6
Brain and Meninges	2	2	2	2	3	4	3	3	2	3
Bones (jaw excepted)	19	17	16	17	15	16	17	16	16	16
Other specified organs	33	32	35	33	34	35	36	35	33	33
Abdominal cavity (organ unspecified)	7	6	6	6	5	5	4	5	4	3
Other and undefined	31	29	25	24	21	20	20	19	17	16

With respect to the table for men, it will be seen that for certain organs the proportion of deaths is almost exactly the same at the beginning of the decade as at the end. In this category we may include lip, mouth and tonsil, pharynx, oesophagus, rectum and anus, breast, penis and scrotum, other skin, larynx, kidneys and suprarenals, bladder, testis, brain and meninges, bones and other specified organs. There are apparently two exceptions to this general rule. These are tongue and jaw. They are probably related, since cancer of the tongue in its later extensions to the jaw may be certified as cancer of the jaw. Taking the two together then as cancer of the tongue, a distinct diminution of the proportional frequency is apparent over the decade. If it be true that a proportion of cancers of the tongue originates in old syphilitic lesions or in conditions arising from defective oral hygiene, it would be reasonable to attribute this decrease to the higher curability of syphilis by modern methods of treatment, and improved hygiene of the mouth. (There is little or no evidence of improved curability rate for developed cancer of the tongue.)

In certain organs there is a definite rise in proportion of frequency over the decade. This is noted in stomach, intestines, lung and pleura, pancreas and prostate. In these more inaccessible sites it seems reasonable to attribute the higher proportional incidence during the decade to improvement in diagnosis

resulting from more highly developed clinical methods or greater accuracy of death certification. There is a decreasing frequency in cancer of the liver and gall bladder, mesentery and peritoneum, unspecified organs of the abdominal cavity, and other undefined organs.

ENGLAND AND WALES

PROPORTIONAL FREQUENCIES OF ALL SITES OF CANCER EXPRESSED AS RATES PER THOUSAND OF ALL DEATHS FROM CANCER, 1918-1927
FEMALES

Site	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Lip	1	1	1	1	1	1	1	1	1	1
Tongue	6	5	5	4	4	4	3	4	4	4
Mouth and Tonsil	3	3	3	3	3	3	3	4	4	3
Jaw	7	7	7	6	6	7	7	7	7	6
Pharynx	3	3	4	3	3	3	3	3	3	3
Oesophagus	19	16	18	18	18	18	19	19	18	18
Stomach	138	141	149	146	156	156	155	160	167	164
Liver and Gall Bladder	116	108	103	102	97	88	85	84	80	74
Mesentery and Peritoneum	12	12	10	9	9	9	9	8	9	7
Intestines	126	122	124	125	123	127	133	132	140	138
Rectum and Anus	63	63	64	65	61	65	61	61	61	62
Ovary and Fallopian Tube	24	23	25	29	31	32	34	32	34	38
Uterus	178	177	170	173	165	164	161	160	153	153
Vagina and Vulva	13	13	13	12	13	14	12	13	14	12
Breast	176	184	186	185	188	188	189	192	184	196
Skin	17	18	16	16	17	16	17	15	15	16
Larynx	6	7	7	6	7	6	7	7	7	7
Lung and Pleura	6	8	8	7	8	8	9	10	9	10
Pancreas	12	13	16	16	18	19	19	19	22	21
Kidneys and Suprarenals	7	8	7	8	7	7	9	8	8	9
Bladder	11	10	11	11	10	13	12	12	11	12
Brain and Meninges	1	1	2	2	2	2	2	2	2	2
Bones (jaw excepted)	13	14	12	13	13	12	14	11	11	11
Other specified organs	17	20	20	19	21	20	19	21	21	20
Abdominal cavity (organ unspecified)	13	13	10	11	10	10	9	9	7	6
Other and undefined	12	10	9	10	10	8	8	8	8	7

Females

Reference to the table will show a similar condition in respect to females. The proportional incidence has remained steady for the decade in lip, mouth and tongue, jaw, pharynx, oesophagus, rectum and anus, vagina and vulva, skin, larynx, bladder, brain and meninges, bones and other specified organs, that is, in the main, the same accessible group of organs as in males.

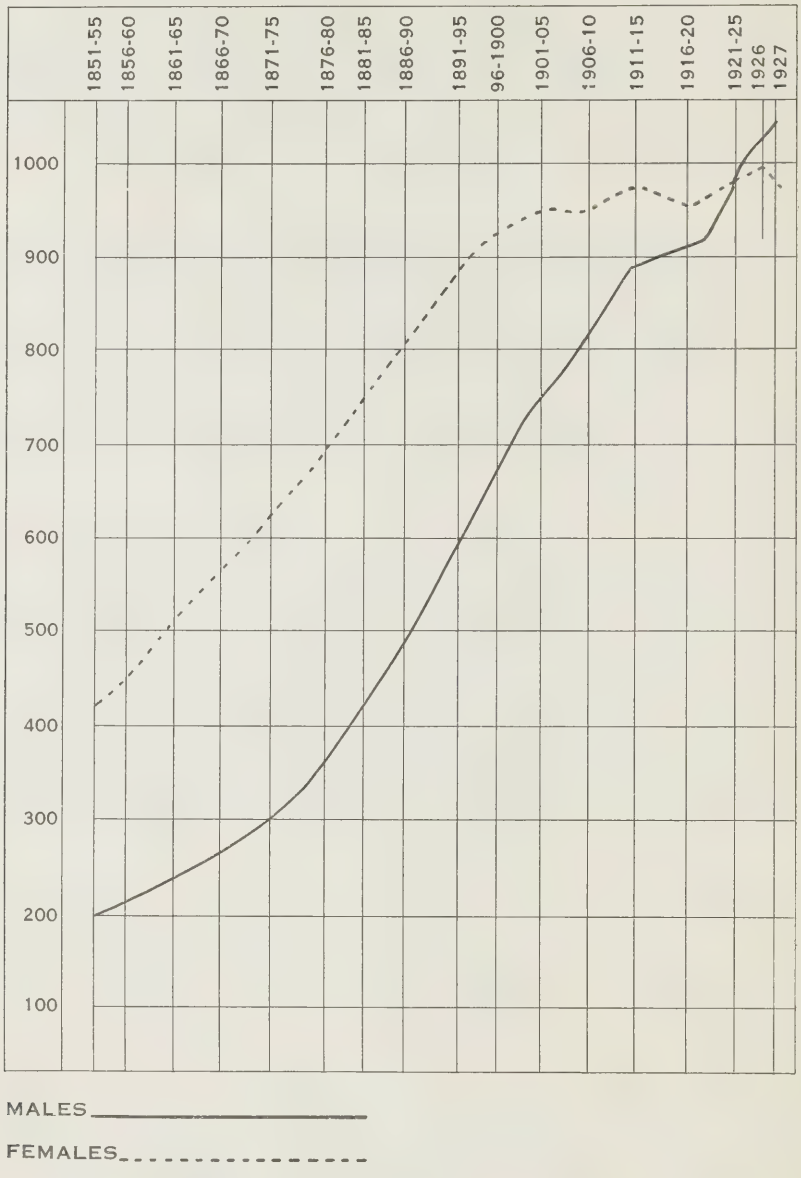
Increased incidence is shown in the same organs or sets of organs as in males—stomach, intestines, lungs and pleura, pancreas and, in addition, some of the sex organs, viz., ovary, fallopian tube and breast. There is an exception, namely, in the uterus. It is well known that mortality from uterine cancer has been falling for some years past, and its explanation is possibly to be found in improvements which have taken place in the care of women during and after childbirth, by diminishing those local effects on the cervix which are accepted as precursory to cervical cancer. The diminution in females, with the

exception of the uterus, corresponds with those mentioned above for males. Generally, then, it would seem from a consideration of these tables, that the susceptibility is of a kind which is steady for both males and females in a certain group of organs, but is at a considerable higher level in males for many organs common to both sexes, than it is in females. In other groups it apparently varies during a decade, increasing in some organs and decreasing in others.

For exposed sites of the body the cancer mortality increases steadily from the highest to the lowest social class of people, while for other sites the mortality is approximately the same for all classes of people. The association of increased mortality with lowered social status is shown for all parts of the digestive system from the lip to the pylorus, for the larynx and for the skin. For all other sites of cancer no such regular association is shown; for them the mortality is with few exceptions approximately the same for social classes. Regarded from this aspect susceptibility or resistance, is a factor which in some organs remains constant whatever the social status, the variation being of a regularly graduated type.

From the above considerations one appears justified in drawing the general conclusion that, of the two factors concerned in the causation of cancer, viz.: previous local disease or injury and susceptibility or resistance, the former is the more important. It would appear that the latter is of a kind which varies with the organ concerned, remaining steady in some sites, increasing or decreasing in others, that it varies with sex and probably also with age.

In regard to the question of susceptibility, to which an important role in the causation of cancer is sometimes attributed, one may note the changes which have taken place in the comparative total mortalities among males and females during the past seventy-six years as shown in the following chart:



From this it would appear that the susceptibility of females in 1851–5 was more than double that of males, whereas about the period 1921–25 the susceptibility of the two sexes was approximately the same. During the past few years, the susceptibility of males has presumably been greater than that of females. In other words, the susceptibility of males is of a different order from that of females, and both show progressive change.

Cancer Mortality in Australia

Type and Seat of Disease

For the year 1928 the following table shows the type of disease and mortality for each type in both male and female:

DEATHS FROM CANCER—TYPE AND SEAT OF DISEASE, AUSTRALIA, 1928

Type of Disease	Males	Females	Persons
Carcinoma	2,061	2,019	4,080
Cancer	422	398	820
Malignant Disease	246	201	447
Sarcoma	143	128	271
Epithelioma	159	47	206
Malignant Tumour	38	48	86
Rodent Ulcer	31	22	53
Scirrhus	1	8	9
Neoplasm	4	6	10
Hypernephroma	15	13	28
Total, Deaths	3,120	2,890	6,100

Seat of Disease	Males	Females	Persons
Stomach and Liver	1,333	832	2,165
Peritoneum, Intestines and Rectum	507	499	1,006
Female Genital Organs	....	557	557
Breast	....	498	498
Buccal Cavity	346	27	373
Skin	109	60	169
Other Organs	825	417	1,242
Total, Deaths	3,120	2,890	6,010

Ages

There were 6,010 persons who died from cancer in Australia in 1928, and while the maximum mortality is found between the ages of sixty-five and seventy, the ages below thirty-five are not immune.

GENERAL FIGURES

Malignant Disease	Total	No Information, Not Improved or Died	Improved	Well at Date	Prophylaxis
Cancer of Cervix	85	38	26	21	...
Vagina	10	4	3	3	...
Body of Uterus	2	2	1	0	...
Skin	98	31	25	42	...
Lip	46	10	9	26	2
Tongue	40	23	12	8	...
Buccal Cavity	59	36	15	2	...
Pharynx	5	4	0	0	...
Larynx	76	11	0	0	...
Bladder	8	5	3	2	...
Prostate	6	8	1	1	...
Rectum	14	6	4	2	...
Breast	20	...	11	...	...
Glands	25	15	9	...	...
Various	8	4	2	...	...
Sarcema Maling Disease	34	21	8	5	...
Various	6	1	2	2	...
Total	483	224	134	123	2
Rodent Ulcer	245	22	36	187	...
Benign Conditions	118	5	35	78	...
Grand Total	846	251	205	388	2

Comment on Results

Results in treatment of tongue and nasal cavity are disappointing. The majority of cases which did not improve were unsatisfactory, owing to development of secondary glands.

In Australia, as in England and elsewhere, the idea of burying radium needles is the thing which has appealed most to the general medical imagination and it has been difficult, because it requires more technical knowledge, to induce centres to develop to the necessary extent application of radium from the surface.

Cancer of the skin shows scope for improvement.

Cancer of the cervix shows twenty-five per cent. of immediate apparently perfect results.

Deep X-rays have given some very gratifying results.

Follow-up has been giving some little difficulty but the number of missing cases are, so far, comparatively small.

The Future

The Australian experiment in cancer treatment and organization has been justified, many people having been completely or partially relieved of symptoms of cancer and there seems definite promise of steady progress in the future.

The standard set should be maintained and improved. This great national experiment should, it is felt, be maintained as a unity. The organization is the nucleus of a great scheme and represents an attempt to deal with the cancer problem on modern lines by methods which bring to bear on the question both national and local powers of organization and initiative.

Cancer Mortality in the United States of America

Cancer in the United States causes ninety-six deaths among every 100,000 of the population (1927). In a population of 120,000,000 this means the annual deaths of about 120,000 persons. In 1900 this death rate was sixty-three. As in most civilized countries cancer has ousted tuberculosis from its former position as a killing disease. In 1900, tuberculosis stood first in this regard with a rate of 201; it has now (1927) dropped to eighty-one per 100,000.

Considerable investigation has been made of the cancer situation in the United States, particularly by Hoffman, whose studies relative to cancer in the large cities, especially in California and in some of the Southern States, are of high interest, showing, as they do, that cancer is increasing among the white population and also among negroes closely associated with whites. Hoffman has also been able to show the low reported cancer rates among various Indian tribes of the United States corresponding to what is reported in respect to cancer among the primitive races elsewhere.

In the registration area during the year 1929, (Bureau of Census, U.S.A.), heart diseases had the highest mortality with a rate of 210 per 100,000 of estimated population; cancer came next with a rate of 96; pneumonia (all forms), with 91.7; nephritis, with 91.2; cerebral haemorrhage and softening, with 86.1; and tuberculosis with 76.0.

The chief regions of the body were affected with cancer as follows: stomach and liver, 32.6; intestines and peritoneum, 14.6; female genital organs, 13.7; breast, 8.8; buccal cavity, 3.0; skin, 2.5.

There was great variation of the incidence of cancer, judging from the mortality, in different states and cities. In 1927, Maine, with a rate of 137.2; New Hampshire, with 134.7; California, with 134; and Vermont, with 131.7, had the highest rates, while the following had the lowest, viz.: South Carolina, 41.2; Arkansas, 41.5; Arizona, 47.7; and North Carolina, 50.3. Only four of the cities, viz.: Norfolk, 55.2; Fort Worth, 59.9; Youngstown, 73.8; and Detroit,

78.4, had rates below 80. The highest rates were found in Albany, 182.4; Cincinnati, 157.7; San Francisco, 156.4; Boston, 154.8; and Spokane, 151.4. The high rates in certain cities and states may be due to the fact that the former are great centres for treatment, and that certain states possess a mild climate which attracts elderly people.

The adjusted mortality rates for cancer taken for different periods show that in ten states in the registration area, this rate increased in the period 1910-20 from 60.7 to 87.8 per 100,000 of population and reached 102.2 in 1927. Between 1920 and 1927 the rates for each six below 45 years showed comparatively slight change, but for the later ages there was a continuous increase, the greatest (258) appearing for males of seventy-five years and over. For the thirty-four states in the registration area in 1920, the adjusted rate rose continuously from 78.3 per 100,000 of population, to 93.2 in 1927. This increase was found in both males and females. In 1928 the mortality rate was 96.1 and in 1929, 96.0 per 100,000 of population.

California

The cancer rate is high in the Pacific Coast States. In California the number of deaths for 1929 were 117 more than for 1928. The total cancer deaths for 1929 were 6,518, an average of eighteen deaths for each day of the year. This represents a rate of 146.4 per 100,000 of population, as compared with 96 for the United States registration area. For the first time in the history of the State, in 1928, the cancer deaths exceeded those from tuberculosis. In 1929 this excess was increased from 328 to 663. Each year the number of cancer deaths increases consistently. Cancer caused ten per cent. of all deaths in California in 1929, while tuberculosis caused less than nine per cent. of deaths that occurred in the State. The migration of large numbers of elderly persons to enjoy the climate of California, is perhaps a factor in the large cancer rate just as migration of tuberculous individuals is a factor in the large tuberculosis rate. Out of the total of 6,518 cancer deaths in 1929, only 874 were persons who had been born in California; 3,447 were born in other States, 2,153 were born in foreign countries, while the origin of 44 is unknown.

Most deaths occur in the last forty-five years of life. The following table gives the age distribution:

Age Group	Numbers
Under 1 year	5
1- 4	19
5-14	12
15-24	33
25-34	124
35-44	515
45-54	1,189
55-64	1,694
Over 65	2,927

Cancer is reported to cause more deaths in women than in men. There were 3,376 cancer deaths in women and 3,142 in men.

New York State

In 1900 the death rate from cancer was sixty-seven per 100,000 of population. In 1928 the rate was 126.7. Deaths and rates from 1924–1928 inclusive were:

Year	Deaths	Rate per 100,000 of Population
1924	12,791	116
1925	13,201	118.2
1926	13,613	120.3
1927	14,333	125.0
1928	14,709	126.7

Exclusive of New York City the figures for the same period were:

Year	Deaths	Rate per 100,000 of Population
1924	6,234	119.9
1925	6,417	121.2
1926	6,580	122.0
1927	6,876	125.1
1928	6,984	124.8

A study of New York figures seems to indicate: (1) That cancer is increasing in the State of New York exclusive of New York City, but not in a constant ratio, the rate for 1928 being lower than that for 1927. (2) If there were 7,000 deaths from cancer in New York State, there must be about 21,000 cases of cancer in the State, all the time assuming that the average life of the cancer patient is three years. (3) As a rule in those countries in which cancer is looked upon as a problem capable of solution, or at least of improvement, the death rate tends to be lower than in those countries in which this is not the case. In New York State in the counties where there are medical colleges and in which the medical profession is awake to the cancer problem, the rates are usually lower than for the State at large, exclusive of New York City. (4) Educational activities are called for, both by the profession and the laity throughout the State, particularly in the rural communities. (5) If we could get the physician and the laymen to regard cancer as a problem to be solved instead of a hopeless situation, further improvement may be expected.

Recent Statistics for Massachusetts

As an indication of the clinical work done in Massachusetts, analysis of the records shows that the total attendance at cancer clinics n 1930 was 2,499, an increase of 393 over the total in 1929.

The percentage of individuals with cancer was 25.5 and of those with precancerous conditions 7.2. The median age of clinic attendance was 50.2 years, and patients came to the cl nics from 191 cities and towns of the State.

The records include interesting data respecting the delay in obtaining treatment. The median delay between first symptoms noticed by the patient and the first visit to a physician was 6.7 months; an interval of 12.1 months existed between the first symptoms and the first visit to a cancer clinic. The longest duration of delay before a first visit to a physician was in skin cancer—14.5 months, and the shortest was in cancer of the uterus, 3.8 months. Before the first visit to a cancer clinic patients with skin cancer delayed for 24.4 months; with cancer of the uterus, 5.5 months. Cancers of the buccal cavity, uterus and breast showed a shorter delay in 1930 than in 1929. The percentage of patients who came to the clinics from physicians was 36.0 per cent. as compared with 34.4 per cent. in 1929. Newspaper publicity proved less effective in 1930 when 31.6 per cent. of cases came because of this stimulus, contrasted with 1929 when 35.4 per cent. came for this reason. Over one-half the patients with cancer or precancerous conditions were referred by physicians.

Cancer of the uterus dropped from 10.9 in 1929 to 2.8 in 1930; of the breast the percentage was about the same, 13.0 per cent. plus; skin cancer showed a slight decrease, while stomach and buccal cancer showed an increase and approximately one-fifth of the total cases had never previously seen a physician.

Swelling and ulceration continued to be the leading causes bringing cancer and precancerous patients to the clinics. Pain brought the largest per cent. of other conditions to the clinics.

Labourers, farmers and carpenters showed the highest sick rate, and farmers delayed the longest of any before visiting the clinics.

Of the cancer cases forty-four per cent. were considered operable with a probable chance of cure. Over four-fifths of the skin cases, over one-half of buccal and oesophageal cases, one-fifth of uterus, breast and other groups, and a very small percentage of stomach cases, were in this classification.

Information of this sort shows the careful study of cases of cancer in Massachusetts and forms a line of action worth copying in Ontario.

Cancer Mortality in Denmark

Denmark, like Sweden and Finland, has a high reputation for the excellence of its medical organization. In 1925 the population of one and one-half millions had 2,142 cancer deaths or 123 per 100,000 of population. This rate has been uniformly high as far back as 1901. It is an acknowledged fact that when the cancer death-rate or mortality from any disease of a country has reached an unusually high point of frequency, a further material increase is not to be expected. The persistent maximum rate for large cities is placed by Hoffman at 150 per 100,000. The cancer mortality in Danish cities and towns 1901-1925 is as follows:

1901—125.2	1908—133.8	1914—145.3	1920—144.5
1902—131.3	1909—141.0	1915—151.1	1921—136.0
1903—124.8	1910—141.7	1916—151.0	1922—149.7
1904—131.6	1911—142.0	1917—148.5	1923—151.1
1905—132.4	1912—150.1	1918—144.0	1924—147.3
1906—131.4	1913—145.6	1919—144.0	1925—145.0
1907—138.2			

It appears that while the deaths have increased about sixty per cent. the population in the meantime has increased about fifty per cent. *The cancer rate of Denmark is probably one of the highest on record for any country at the present time.*

In 1925 there were 4,744 deaths from all forms of cancer, giving a rate of 135 per 100,000 population; of these, 36.5 per cent. were from cancer of stomach; 7.0 per cent. from cancer of the breast; 49.6 per cent. from cancer of other organs and parts.

Cancer Mortality in Holland

Cancer in Holland is on the increase. The cancer rate for males in Amsterdam rose from 109.5 in 1905-09 to 118.2 in 1915-19, and that for females from 107.0 to 119.7. Between 1875 and 1914 the rate increased from 60.6 to 114.6 for males and for females from 79.1 to 114.9. In 1890 the rate was 83.2 per 100,000 of population for both sexes; in 1910 it was 121.1 and in 1920 it was 127. There were thirty deaths from cancer of the breast in 1905 and forty-six in 1920. While there were fifty-one deaths from cancer of the female genital organs in 1905, there were eighty-one in 1920.

Cancer Institute

The Dutch Cancer Institute at Amsterdam is said by Hoffman to afford an inspiring experience. Those in charge are said to represent the finest type of mind that could be brought to bear upon the scientific consideration of cancer questions. Professor De Vries, referring to the Amsterdam statistics, is of the opinion that "Mortality returns give too favourable an impression of the prevalence of cancer in general, and probably also of some important forms of cancer particularly cancer of the stomach and intestines." He emphasizes the importance of a joint consideration of autopsy and mortality returns.

Cancer Mortality in Switzerland

Francis Carter Wood, M.D., of New York, a leading cancer authority, made the statement in the *New York Times* in 1927 that "Cancer in Switzerland has not increased during the last twenty years." This statement appears to be negatived by the following figures (Hoffman):

CANCER RATE OF SWITZERLAND, 1915-1926

Year	Cancer Deaths	Rate per 100 Thousand
1915	4,614	118.9
1916	4,677	120.5
1917	4,838	124.5
1918	4,874	126.3
1919	4,880	126.0
1920	5,018	125.9
1921	5,062	129.2
1922	5,051	130.1
1923	5,421	129.5
1924	5,319	135.1
1925-26	5,356	135.3

In Basle the local cancer rate has increased from 135.4 in 1901 to 196.4 in 1925, and in 1918 actually reached 217.7. In this connection the rate for certain European cities is of interest.

CANCER MORTALITY—EUROPEAN CITIES

(Rate per 100,000 Population)

Age	Vienna	London	Paris	Basle
Males:				
20-29	9.7	7.5	4.3	6.3
30-34	22.1	15.0	14.3	24.5
35-49	38.6	38.5	26.2	29.1
40-44	73.9	62.7	49.7	89.3
45-49	159.7	134.1	133.8	177.8
50-54	314.4	280.8	267.0	301.7
55-59	510.0	465.1	420.1	512.5
60-64	807.9	705.3	616.8	897.8
65-69	931.1	938.6	753.0	1,024.6
70-74	1,276.3	1,115.7	911.2	1,767.0
Ages 20 and over	136.9	130.0	111.9	235.3
Females:				
20-29	11.5	6.4	6.3	2.6
30-34	36.8	26.1	29.8	6.0
35-39	62.5	55.8	52.0	34.0
40-44	128.1	100.6	119.1	61.7
45-49	216.2	188.7	198.7	142.2
50-54	332.1	279.1	282.2	335.0
55-59	415.7	390.5	404.4	395.0
60-64	463.8	535.3	512.2	471.9
65-69	742.2	652.2	661.2	721.5
70-74	979.4	823.4	727.7	1,053.7
Ages 20 and over	149.8	129.6	133.9	192.7

During 1921-25, 45.6 per cent. of the deaths from cancer occurred in hospitals, while 41 per cent. of the dead in the city and canton of Basle came to autopsy.

No such figures are reported for any other country or section in the world.

Cancer Mortality in Norway

A thoroughly scientific study of cancer has been under way for a number of years. Professor Gade, who is a leading authority and Chairman of the Cancer Committee, places the mortality for 1911 at 95 to 100,000 of population, and for the period 1902-1911, 107.

The urban population of Norway is relatively small, and cancer seems to be distributed about equally between city and country, but, curiously enough, that of Oslo and Bergen, the leading cities, is low. Towns along the Skagviak have high rates, 140 to 158. Here there are many old, retired sailors. Sarcomas account for 5.36 per cent. The rate for the sexes is about the same.

Cancer in Norway by Organs and Parts, 1902-1911

	Male	Female	Total
Cancer:			
Stomach	7,037	5,712	12,749
Liver	751	755	1,506
Sexual Organs	125	1,343	1,468
Breast	4	838	842
Other Organs	2,175	2,076	4,251
Total	10,092	10,724	20,816
Sarcoma:			
Osseous System	258	197	455
Other Organs	363	342	735
Total	621	569	1,190
Grand Total	10,713	11,293	22,006

Mortality from Cancer by Organs and Parts, Norway, 1903-1911

Age	Number of Deaths	Rate per 100,000
20-30	108	3.23
30-40	586	21.25
40-50	2,067	91.79
50-60	4,498	231.65
60-70	6,183	443.03
70-80	5,610	680.11
80-90	1,790	549.90
90 and over	88	289.00

Besides there were 21 cancer deaths below the age of 20 years due, chiefly to cancer in ovaries, uterus and breast.

In 32.5 per cent. the disease had occurred in other members of the family, or in neighbours or near friends.

In 1924 the cancer rate of Norway was 111.4 per 100,000—the total deaths in 1924 were 3,056, four being under one year, nine from 1 to 4 years, seven from 15 to 19, and 11 from 20 to 24, with steady deaths from cancer at 90 to 99.

Cancer Mortality in Sweden

There are some interesting things in respect to cancer to be found in Sweden. That country, or at least the city of Stockholm, has had registration of vital statistics for perhaps longer than any other country in the world, and a medical profession fully the equal of any as regards competency and accuracy of diagnosis. The death-rate from cancer increased rapidly from 1861 to 1869, when it had reached 105 per 100,000 of population. Then it fluctuated more or less, dropping to 88 in 1890. From 1891 onward except for the year 1904 (when the rate was 94), it has never fallen below 100 per 100,000 population. In 1908 the rate was 128, in 1924, 124, after which it has risen steadily, being 144 in 1925 and 142 in 1926.

The most suggested increase has been the mortality from cancer of the uterus of which there were 700 deaths in five years (1917-24), and 928 in the period 1921-26.

Cancer Mortality in Russia

Hoffman states that the incidence of cancer in the whole of the Union of Soviet Republics in 1924 was approximately 150,000 or a mortality rate of 100 per 100,000. He is inclined to accept these figures with reservations, but has no doubt of the fact that cancer in Russia is increasing. For Leningrad the mortality rate has risen from 76.5 in 1885 to 118.0 in 1926. For Moscow, the rate of 87.4 in 1894 had reached 95.9 in 1924.

Hoffman expresses a profound admiration for the management of the Leningrad Cancer Institute, considering the limitation of means preceding rapid expansion. The radium and X-ray equipment, he says, is admirable, but the institute lacks the best type of instruments.

High praise is given the Director, Professor Anna Jugenburg, who, he says, possesses high qualifications and enthusiasm for her work.

Cancer Mortality in Finland

The statistics for Finland, apart from those of large hospitals, are said to be incomplete. Those for the cities indicate a mortality rate of 108 per 100,000 of population, which conforms more or less to those of other Scandinavian countries.

From a table of the rates of cancer mortality in hospitals it appears that the death-rate has risen from 3.8 per cent. in 1896 to 8.11 per cent. in 1923.

The life insurance companies find the cancer mortality increasing among their policy-holders.

Cancer Mortality in Germany

The cancer mortality figures for Germany, as supplied by the Federal Board of Health (1920-1925), indicate the usual general increase observed in other countries.

For males there was an increase during this period from 79 per 100,000 population to 93, and for females from 95 to 110. For both sexes combined, the increase was from 87 to 102. The most marked increase was observed at ages over 70, or respectively, for males from 692 cases to 802 cases, while for females there was an increase of from 639 to 742.

In the city of Hamburg there has been an increase in the cancer death rate at all ages of from 126 per 100,000 during 1921-1925 to 130.9 during 1926.

Cancer Mortality in France

In 1927 the cancer deaths were 38,508, there being 16,945 males and 21,563 females. Cancer deaths formed 5.7 per cent. of all deaths. The mortality rate for males was 86.4 and for females 102.6, or a general rate of 94.5.

Roussy and Hereaux, from a study of cancer statistics of European countries, Canada and the United States conclude that there has been an increase of cancer mortality, but not so large as some of the statistical reports lead one to believe. However, the 38,508 deaths in one year in France indicate that cancer is a problem of no small magnitude in that country.

Cancer Deaths in Bulgaria in 1927 were 3.7 per cent. of all deaths, the total deaths from this cause in 1925, 1926, and 1927 being respectively 578, 664, and 713.

In Czechoslovakia, in the years 1921-27 the mortality has steadily increased from 297 per 100,000 of population at 40 and over to 359 in 1927.

In the Grand Duchy of Luxembourg, the cancer deaths in 1925, 1926 and 1927 were respectively 133, 142 and 152.

In Hungary the number of cancer deaths rose from 6,942 in 1925 to 7,521 in 1927.

In Italy, while the deaths from malignant diseases in the period 1921-1925 have shown a decrease of 13.0 per 100,000 of population, there has been a steady increase in the city of Milan of 22.0 per 100,000 of population from 1901 to 1905.

Cancer Deaths in Scotland during the fifty years, 1878-1928, have increased from 51 per 100,000 of population to 141.

In Esthonia the mortality rate in persons over 40 has increased in the years 1921-28 from 151.0 per 100,000 of population to 216.

In Spain the total deaths in 1928 were 15,727 and formed 3.8 per cent. of all deaths.

In Portugal in 1925 there were 1,975 deaths from cancer, or 1.8 of all deaths.

Cancer in India

Referring to the commonly accepted statement that cancer is less prevalent in primitive than in white races, Sir Leonard Rogers, one of the foremost pathologists of the age, writing in the *Glasgow Medical Journal*, January-February, 1925, states:

(1) Malignant tumors, both connective tissue and epithelial types, are about equally common in Bengal and England, with a slight excess in the tropical country, which is quite contrary to the statements of those who maintain that civilized races suffer eight times as much from them as do uncivilized peoples.

(2) Both innocent and malignant connective tissue tumors are considerably more common in Bengal than in England, while the reverse is the case with both innocent and malignant epithelial tumors, which supports the view that the innocent forms shade off into or may take on the characteristics of malignant ones.

(3) The slightly lower incidence in Bengal of the malignant epithelial tumors of carcinomata is fully explained by the age factor, as the higher rate in London is more than accounted for by the great excess of persons of the cancer age of over 40 or 50 years in England as compared with Bengal.

(4) Cancers of the tongue, esophagus, stomach, large intestine, and breast show considerable excess in London pathological examinations, while those of the skin, penis, both the cervix and body of the uterus, liver and gall bladder are in excess in India. Nearly all of this is explainable by the known laws of long-continued irritation being the most important predisposing or exciting cause of cancer.

(5) The three-fold excess of cancer of the uterus in Bengal is probably related to early menstruation, child-bearing and menopause in the Bengali race leading to earlier and more frequent development of cancer in them as compared with European females.

(6) In future the onus will lie on those who proclaim the rarity of malignant growths in uncivilized races of proving their assertions by extensive and accurate pathological data such as those upon which the above conclusions are based, for about 90 per cent. of the Bengal population who furnish a large proportion of the Calcutta hospital cases live in villages under primitive conditions and on a diet of natural foods.

While the foregoing statement flatly contradicts many of the prevailing views regarding cancer in the primitive races they open a wider field of conjecture. But the fact must not be overlooked that the Calcutta mortality data were based upon 1,600 post-mortems while they are compared with corresponding post-mortems for St. Mary's Hospital, London, and made available through Drs. Kettle and Newcomb, the former of whom is a distinguished pathologist and authority on tumors. Sir Leonard Rogers further points out that "the prevailing type of malignant disease (in Bengal) is chiefly sarcoma which is met with twice as frequently in Calcutta as in London. The very malignant small-cell sarcoma shows 110 in Calcutta as against 23 in the London series; the melanotic form is more frequent in dark-skinned races."

Sarcomas are said to be more frequent in dark races.

The New Journal of South Africa says: "That among Asiatics primary hepatic cancer is remarkable frequent, intestinal cancers rare and that the age incidence in uterine cancer is remarkably low." *The Journal* concludes that the alleged rarity of cancer in the tropics is more apparent than real, chiefly because the age incidence is not taken into account, and that when we are in a position to compare reliable data, it will be found that there is no great difference in the incidence of European and tropical group, but that there does exist a remarkable difference between the two as regards the site incidence of cancer.

The experience of the Oriental Government Security Life Assurance Company, Limited, Bombay, for 1912-21, shows that for the first five years of the period they had 3,928 deaths of which 61 or 1.6 per cent. were from cancer. The highest relative rate of frequency was in 1913 when the proportion was 2.2 per cent., the different racial elements contributing as follows:

	1912–16	1917–21
Hindus	1.1%	1.0%
Europeans	4.7%	3.6%
Parsees	2.2%	0.9%
Mohammedans	0.8%	0.8%

During the five years ending with 1921 there were 5,345 deaths with 69 or 1.3 per cent. from cancer. The highest rate of proportionate incidence was in 1918 and was 2.3 per cent. of the percentage for the races.

Kangri-Burn Cancer

Sir John Bland Sutton in his work on tumors observes that according to Neve, in twenty years at the Kashmir Mission Hospital, out of 4,902 tumors removed 1,720 were malignant, 1,189 were cancer and of these 848 were on the thighs and abdomen. The frequency of skin cancer among the Kashmiri is attributed to the use of a portable fire-basket called a kangri, consisting of an earthern pan containing burning charcoal in a basket which, suspended from the waist under the loose robes, keeps the person warm. The average duration of life in a kangri-burn is fifteen months; in 10 per cent. of the cases 1 to 5 years, and even as long as twenty years. The burn may be due to the heat or the tar, or both. At all events this type of burn is limited to the people of the highlands of the Himalayas who use the kangri.

APPENDIX B

INDUSTRIAL OR OCCUPATIONAL CANCER

INDUSTRIAL OR OCCUPATIONAL CANCER

There seems to be a definite relationship between the incidence of cancer and certain occupations. The chief of these occupations are:

(1) Work in tar, pitch, and bitumen briquettes.

(2) Work in mineral oil or paraffin or in any compound, product or residue of either of these products.

(3) Work in arsenic.

(4) Work in X-rays and radium.

(5) Work in mines, e.g., the lung affection of Saxon miners called "Bergkrankheit."

(6) Chimney-sweeps' work.

(7) Work in aniline dyeworks.

The specific irritants or carcinogenic agents appear to require a long time to show their effects. They appear to be selective, in that certain animal species, certain strains, certain individuals and certain tissues only are vulnerable to their operation, e.g., cancer of scrotum in chimney-sweeps; cancer of the urinary bladder in dyeworkers.

1. Workmen constantly exposed to tar or pitch, such as retort men in gas works, road sprayers and briquette makers are liable to develop skin cancers. Animal experiments seem to show that cancer can result long after the irritant is withdrawn. Thus, in some cases of cancer the antecedents of which are hidden from us, some irritant may have been in action and have disappeared, leaving no evidence of its presence long before the cancer declared itself.

2. For fifty years it has been known that workmen exposed to the action of crude products obtained by distillation of the oil-bearing shales of Scotland and of the lignite of Germany, are prone to develop skin affections, papillomata and epitheliomata, especially on the arms and not infrequently on the scrotum.

Mulespinner's disease (epithelioma of the scrotum) is fairly common in Lancashire and other places where cotton is manufactured. It is attributed to soaking of the parts by the lubricating oil thrown off the spinner. This type of cancer affects by preference the left side of the scrotum, the more exposed to oil, but also the thighs, forearm, face and neck. Approximately 2.5 per 1,000 mulespinners develop this disease.

3. *Work in Arsenic.*—Arsenic cancer has been seen in the very dusty process of manufacturing "sheepdip" which is an arsenite of soda containing arsenic sulphide and free arsenious acid.

The resulting disease is a squamous-cell cancer. There are pigmentation, keratoses and single or multiple malignant growths on face, abdomen, buttocks, clavicle or lower chest.

J. A. Paris in 1820 described arsenic cancer of the scrotum in tin smelters.

4. *X-ray Cancer.*—Most of us know one or two X-ray workers who have lost portions of fingers, a hand, or their lives, from neglect to protect themselves against the X-rays. There is probably less of this now because the danger of such neglect is better known. Similarly, neglect to use protection against radium is dangerous. The protective agent is lead.

5. "Bergkrankheit" is a pulmonary affection known for several centuries among the miners of the Erzebirge of Saxony, which as a rule proves fatal in middle life. The disease has been known since 1897 to be due to malignant tumours of the lungs. An inquiry into the subject was initiated in 1922 lasting 3¼ years. This inquiry showed that the dust contained bismuth, cobalt and arsenic and that the air was radio-active.

The course of the disease is marked by bronchitis, dyspnoea, noisy breathing, emaciation and death, the process lasting for years. No satisfactory etiology has yet been solved.

6. *Chimney-sweeps' Work.*—Leitch, (*British Medical Journal*), says that this form of cancer is probably as common to-day as ever it was. There are five or six deaths from it a year in England. It is practically unknown on the continent, relatively common in Ireland, very rare in Scotland, and absent from those countries where the practice of putting boys into chimneys to clean them is unknown. The exciting agent is soot and the soot of the more bituminous coal from the Midlands is said to be the most tumour-producing.

7. *Aniline Dyeworks.*—Furriers and dealers in skins show a mortality from cancer above the average. It may be that the use of aniline dyes has something to do with this mortality. The disease shows a preference in dyeworkers for the urinary bladder.

With reference to lead workers, Hoffman states that he has made an analysis of nearly 2,000 death certificates of lead workers in the United States, and in not a single instance did he find evidence of malignant tumours given as a contributory cause of death. If there is anything in the lead treatment of cancer, the significance of the foregoing is apparent.

* * * * * *

Statistics show that in the last few years, cancer has steadily increased its toll among industrial classes, both in Canada and the United States. A further important phase of the cancer problem was brought out by statisticians of the Metropolitan Life, following an analysis of the cancer mortality data of 1931, to determine what organs or parts of the body have been chiefly affected by the rise in the disease as compared with 1930. The analysis indicates that there was an 8 per cent. increase for cancers of the digestive tract and peritoneum. This group includes the very large number of deaths from cancer of the stomach, liver, gall-bladder and intestines. In the case of cancer of the breast, the increase in deaths was 6.3 per cent.

APPENDIX C

CANCER ORGANIZATION

CANCER ORGANIZATION

In the main report a brief account is given of the effort in cancer control in the countries visited by the Commission. In the following pages is detailed the fine type of organization for this work in Australia.

Australian Cancer Organization

A few years ago a group of public spirited citizens formed a cancer treatment and research committee, appealed for funds and raised £130,000 in Sydney and New South Wales. Representations to the Commonwealth Government resulted in the purchase by that Government of ten grammes of radium and a radium advisor was appointed to see that it was properly used.

Shortly before this the Minister of Health appointed a cancer advisory committee of prominent medical men and scientists to advise on the cancer movement in Australia, and local efforts were encouraged by grants to each research and treatment fund as it was raised in New South Wales, Queensland, South and West Australia. The Commonwealth Government gave grants of £5,000, while in each instance the separate State Governments gave to their own funds a like contribution. So far (1930) Tasmania and Victoria have not fallen in line but have the subject under consideration.

Radium Centres

The national organization has been largely built up around the Commonwealth purchase of radium. It was recognized at the beginning that for the public to receive the maximum benefit from radium treatments it must be administered only by those competent through experience and teaching to give it, and for the further purpose of rendering the radium treatment offered more efficient, the radium should be located at large centres where considerable quantities of radium were available. A centre was established at each of the six capital cities and to accommodate other considerable centres of population, radium centres were established at Townsville, Newcastle, Lancaeston, and Bendigo. Only a limited amount of work is done other than at the large city centres.

In each capital city the centre is established at the main teaching hospital or if no teaching hospital exists, then at the largest public hospital. In Sydney and Adelaide, where each research committee is a committee of the university, the latter has been given charge of the radium. In Brisbane, Melbourne, Perth, Hobart and the minor centres the radium has been placed in charge of the local authority governing the hospital and loaned under a definite agreement providing for safety, instruction, treatment, etc.

The local authorities have, in addition to the radium provided out of local funds, deep X-ray machines. Case sheets are kept on forms provided by the Government.

In every centre a *consulting committee* has been formed of a limited number of physicians, surgeons and specialists which meets at regular intervals and discusses every feature of the service. No one is allowed by the Department of Health to handle radium unless he agrees to give a certain definite minimum of time weekly to this work. It is felt too, that it is better for the patient with a major affection to go to a larger centre.

In some states free passes are given to poor patients to the main centres.

Diagnosis and Research

In the great cities adequate facilities are provided for pathological examinations of tumours; these and usually histological examinations can be obtained free of charge. In Perth, part of the cancer fund is used in provision for a well-equipped pathological laboratory, which will form part of a cancer block in the course of erection.

Some time before the cancer movement originated, the Commonwealth Government had started and carried out the policy of providing and staffing pathological laboratories in many of the smaller centres which were not well equipped with facilities for pathological examinations. These laboratories are now very useful in the cancer movement. The plan is something like the Ontario laboratory system.

Research on a considerable scale is being carried on under the cancer research committee of the University of Sydney and with the help of the Commonwealth Government in Melbourne and Adelaide. At the Commonwealth Serum Laboratories at Melbourne, special investigation is in progress.

Research is encouraged at every cancer centre. In addition to X-rays and radium, diathermy and lead treatment have been tried.

The Department of Health acts as a co-ordinating factor between all the cancer centres and publishes in its journal health articles and items of interest on cancer. Posters and pamphlets are published as part of an education campaign.

A department emanation centre has been established at the University of Melbourne and radium emanation is now in daily use. Another emanation centre is now complete and producing radon at the University of Sydney, a trained physicist being in charge of each plant.

Australian Results of Treatment

Until the end of 1929 over 3,000 cases were treated at the new centres, approximately 2,500 by radium. One of the hospitals in Australia which became a radium centre already possessed deep X-ray apparatus; others were waiting delivery so that in the case of Melbourne, the numbers of patients treated did not include those treated by deep X-ray, but the figures are available for the deep X-ray cases treated at the Royal Prince Alfred Hospital, Sydney. The number of cases treated at each centre is roughly proportioned to the population of each state and about eight per cent. of the 2,500 cases treated were not malignant.

The organization and development of the anti-cancer movement is owing to a large extent to the advice and guidance of Arthur Burroughs, M.D., Director of Irradiation at the London Hospital.

APPENDIX D

X-RAYS AND RADIUM

X-RAYS AND RADIUM

Roentgen or X-rays

The discovery of the important series of radiations known as X-rays or Roentgen rays was made by Roentgen in Wurzburg in November, 1895, while he was experimenting on the passage of electricity through rarefied gases contained in Geissler tubes.

A great deal of exploration in the realm of the discharge of electricity through gases in which the findings were largely of a qualitative character had been carried out by such men as Plucker, Hittorf, Thomson and Crookes, and it was known, among other things, that the character of the discharge depended upon the size and shape of the electrodes, on the potential applied to the electrodes, on the nature and pressure of the gas and on the size and shape of the containing vessel. It was also known that the discharge was of a two-fold character, that the negative charges were shot out from the cathode or negative terminal, and positive charges from the anode or positive terminal, and in particular that when the pressure of the gas was low enough that the radiation proceeding in straight lines from the cathode revealed itself by a fluorescence of the walls of the tube. Moreover, it was shown that this radiation could be bent out of its straight path by a magnet. The movement of the fluorescence when the magnet was presented, together with many other experiments, demonstrated conclusively that the radiation from the cathode consisted of negatively charged particles—now called electrons—moving with high velocity down the tube away from the cathode. Also, by means of effects observed when electric and magnetic forces acted upon the corpuscles, it was shown that the corpuscles had very small and equal mass, and as we now know are constituents of all gases, as indeed of all materials. These cathode rays have only a feeble penetrating power in glass. In 1895, when Roentgen was engaged in an investigation of the discharge of electricity through gases, he found that even if the discharge tubes were covered with black paper, so as to prevent the emission of light, yet another type of radiation was proceeding outward from the anode and the walls of the tube.

This new radiation apparently arose wherever the electrons impinged on solid matter and were thus brought to rest. He detected it by its power of causing certain crystals, such as barium platino-cyanide to fluoresce, and by the fact that it affected photographic plates in the same way as does ordinary light. The radiation penetrated not only the glass walls of the tube, but other substances such as wood, ebonite, flesh, and to a small extent even metals such as lead, which are opaque to ordinary light.

The character of the radiation was also affected by the degree of evacuation of the tube; the higher the voltage between the ends, the more intense and penetrating the radiation emitted. These rays, being of unknown origin, were termed X-rays, although often referred to now, particularly in Germany, as Roentgen rays. The announcement of Roentgen's discovery was made to the Physico-Medical Society of Wurzburg in November, 1895, and was published

in the Bericht der Physikalische-medische Gesellschaft of Wurzburg in December 1895, and March, 1896.

The value of Roentgen's discovery, as is very rarely the case in scientific work, was at once perceived and throughout the world the discovery was applied to medical, and in particular, to surgical purposes.

X-rays are emitted whenever matter is bombarded by cathode rays or in other words, the sudden stoppage of swiftly moving electrons by the atoms of matter is accompanied by the generation of X-rays. The essential parts, therefore, of an X-ray generating apparatus are, a source of electrons proceeding from a cathode, a target or anticathode, and a means of applying a potential difference between the cathode and the target which will accelerate the electrons, to the requisite velocity during passage across the intervening space.

There are several types of X-ray tubes at present which fulfil the requirements and which may be classified according to the method by which electrons are produced for the passage of current through the tube, namely: 1. By the ionization of the residual gas in the tube. 2. By the emission of electrons from a heated filament cathode. The tubes may be made purely of glass or of glass and metal.

When a potential is applied across the anode—known as the target—and the cathode, there is a tendency for electrons to be emitted owing to the electric field applied between the electrodes. The electrons are accelerated by the electric field and pass from cathode to anode and by their impact on the latter, the energy of electronic motion is transformed into energy of electromagnetic radiation, a part of which appears as radiation corresponding to that region of the spectrum that we term X-rays, although a far greater proportion appears as heat and light radiation. So many factors are involved in the operation of gas-containing tubes that they may be erratic in their operation, but in the hands of skilled radiologists and radiographers they can give highly satisfactory results. In the hands of the unskilled, however, the great fluctuations in the intensity and wave length of the X-radiation emitted cause it to be regarded with disfavour.

In the electron type of tube there is insufficient gas present to allow the passage of the current. Electrons are emitted from a heated filament, which serves as the cathode for the discharge. The advantage of a tube which is dependent for conduction only upon the emission of electrons from a filament is that the current through the tube is dependent only upon the temperature of the filament and the cathode ray stream is much more uniform and steady with respect to quantity and velocity than in the case of gas-containing tubes. It is possible, too, when sufficiently high voltages are used, to make the current and the voltage independent variables. The electron type of tube is associated in this country with the name of Coolidge, who introduced it in 1913. As an example of other types of electron tubes, there is the Lillienfeld tube which had been produced previously in Germany. In it the independent control of current and voltage was even greater than in the Coolidge tube. The tube is similar to the Coolidge tube, but it has an auxiliary anode whereby a more uniform cathode ray stream is obtainable. By maintaining a constant potential across the cathode filament and the anode or target, the wave length of the radiation is maintained constant, and as a result the radiation is more homogeneous.

One of the most marked revolutions in radiology during the past few years has been the rapid adoption of X-ray tubes carrying their own metallic protection against the emission of undesired X-radiations. Such tubes have been named

"metal tubes", somewhat of a misnomer, since for purposes of insulation they must necessarily be partly of glass or other insulator.

One of the needs of the present time is, however, the production of tubes that will operate satisfactorily at voltages above 220 kilovolts. Although tubes have been operated above this value they are not yet highly practical, but they will extend the value of radiology with respect to medical purposes. If tubes could be produced to operate at 1,000 kilovolts it should be possible to obtain radiation analogous to the gamma radiation from radium and this would allow important therapeutical extensions, particularly since there is some reason to believe that the most advantageous radiation for cancer treatment actually lies above that of the present day high voltage X-rays, but well below that of the gamma radiation from radium, and, moreover, we are able at present in a practical way to modify the latter. X-ray tubes have already been operated in the United States of America and in Germany with voltages of 750 kilovolts, but the equipment is not yet suitable for use by the practising radiologist.

As an illustration of this, we have the work of Failla at the Memorial Hospital, New York, where he has been using the cascade X-ray tube developed by Coolidge of the General Electric Company. This tube is designed for a maximum voltage of 900,000 volts and has been run at 850,000 volts for short intervals. It can be operated for long periods at 700,000 volts and 5 milliamperes. The radiation output of the tube has been determined as to quality and intensity at different voltages. At 700,000 volts and five milliamperes the radiation emission through a filter of five cms. of copper is equivalent to a gamma ray emission from approximately 500 grammes of radium. With such apparatus the question of personnel and protection becomes of supreme importance.

The Production of High Voltages for the Excitation of X-ray Tubes

In the earliest period of X-ray history the source of high tension energy was either a Wimshurst machine or an induction coil. Owing to the vagaries of the former, the coil soon dominated the practical field. For a long period the induction coil was practically the only method of exciting the X-ray tube. At present the alternating current transformer is almost universally used. With its introduction the output of X-rays available was considerably increased and the scope of radiographic work materially extended. It is, moreover, capable of much greater and more regular output. For the satisfactory performance of an X-ray rube, the current through it must be uni-directional. As a rule, therefore, the high tension transformer alone is not sufficient for a complete high voltage X-ray outfit. Some device must be added to ensure that the current through the tube flows always in the same direction. For this purpose one of two types of rectifiers is generally used; either the mechanical or valve rectifier. The objection to the mechanical rectifier is the noise of the rotating parts and the production of fumes due to spark discharge. Within the last few years, improvements in thermionic valves have resulted in the use of valve tubes for rectification purposes in X-ray work. This type of rectifier has the advantage of noiselessness and for this reason has been widely adopted. Each type of rectifier has its advantages and disadvantages both from a theoretical and practical standpoint. The greatest advance in X-ray apparatus has been in the direction of producing better and more powerful apparatus to excite the X-ray tube, and in this respect the requirements have been adequately met up to the present.

The Physical Nature of X-rays

The nature of X-rays was for a long time a baffling secret. It was known that the cathode rays which produce them are corpuscular, that is, they consist of electrons, units of negative electricity whose charge and mass could be accurately measured. As X-rays have some properties in common with cathode rays, it was thought for a time that X-rays were also corpuscular, but it was gradually recognized that they are a wave motion in the ether like visible light and differing fundamentally only in wave length. They are similar to wireless waves, heat rays, visible light, ultra violet light and gamma rays from radium; that is, they are electric wave motions or a series of electrical disturbances following each other at very short intervals of space and time. Associated with these electric waves are magnetic waves, both sets being perpendicular to the direction of propagation of the system; that is, they are electro-magnetic in their nature. This was confirmed by Friedrich and Knipping and latterly the Braggs, who, acting on the suggestion of Laue, used the regularly arranged planes of atoms in a crystal as a natural grating to produce the same phenomena with X-rays that Fresnel, with other methods, had produced with visible light.

This discovery assigned to X-rays their place in the now complete electro-magnetic spectrum which Maxwell had foretold and which consists of a continuous chain of ether waves of every conceivable wave length. These wave lengths stretch from the cosmic-rays, whose wave lengths are excessively small, through gamma rays, X-rays, ultra-violet rays, visible rays, heat rays or infra-red rays to wireless waves of wave lengths ranging up to a mile or so in length. As an illustration of the range of wave lengths, it may be pointed out that the wave lengths of the spectrum of visible light range from about 3.5 to 7.0 ten thousandths of a millimetre and the X-ray spectrum from about .1 to 2 ten millionths of a millimetre in length.

X-ray Spectra

There are two main types of optical spectra (*a*) continuous, containing a wide range of wave lengths without intermission and emitted by incandescent solids, (*b*) line spectra consisting of isolated wave lengths characteristic of the emitting substance when it is in the gaseous state. The fundamental way of dealing with X-ray spectra must be the same as that adopted for ordinary light, that is, they must be sorted out into their wave lengths and it must be found out how much there is of each. It has been found that X-ray spectra may be divided into the same two categories, both the continuous and the characteristic line spectra being observed, while in general the spectrum of the radiation emitted from a tube operated under deep therapy conditions consists of a superposition of the two types. By choosing conditions correctly it is possible to obtain either type free from the other. With regard to the continuous spectrum it is known that (1) an X-ray tube emits a wide range of wave lengths at the same time, that is, the radiation is very heterogeneous, (2) the higher the voltage the greater the relative amount of short wave length radiation, although by raising the voltage the actual emission of long waves is also increased, the short wave emission being, however, increased to a greater extent. (3) There is a minimum wave length to the radiation emitted at any given voltage. From an X-ray tube we have also X-ray spectra consisting of lines whose wave lengths are characteristic of the element producing them. We may now sum up the radiation emitted from an X-ray tube as a whole by stating that below a critical voltage the whole of the radiation is continuous, but under the usual therapy

conditions the voltage is always sufficient to cause also the emission of the characteristic types of radiation. These appear in addition to the other radiation and cause apparently no decrease in intensity of the former. Their wave lengths depend upon the metal used as the target in the tube, the heavier the element the more penetrating the radiation. Thus, an X-ray tube emits a wide range of waves at one time, the wave lengths escaping from the tube being limited on the short wave side by the maximum voltage applied, and on the long wave side for unfiltered radiation, by the transmission through the glass walls of the tube. Thus, the spectrum is that of a very heterogeneous collection of rays. To define any electromagnetic radiation it is necessary to specify the wave length or quality of the radiation and the intensity of the radiation. Knowing the latter we can determine what we term "dosage" since this is the product of intensity and time of application.

If we wish to profit by the experience of others or repeat results obtained previously, or to communicate them to others, it is essential that quality and intensity of the X-ray radiation producing certain effects be measured and described accurately so that the same conditions may be repeated. The effects produced by X-rays, either in a photographic film or in the human body, depend upon the amount of radiation that has been absorbed in either case. This amount of absorbed radiation is determined by: (1) the intensity of the rays. (Intensity corresponds to what we call "brightness" when speaking of visible light). (2) the time for which the photographic film or the human body is exposed to the radiation of any given intensity. (3) the wave length or penetrating power of the X-ray beam. These are the three main factors, but as intensity itself depends largely upon voltage and absorption, and scattering depends upon the wave length, the two factors, intensity and wave length, are somewhat interlinked and should be separated.

The Quality of X-rays

There is only one accurate method of the measurement of X-ray quality, namely, by means of the X-ray spectometer. Laue, Friedrich and Knipping in 1912, were the first to measure definitely the wave length of X-rays by their diffraction through crystals. Their method was dependent upon complex considerations and in the following year Bragg originated a modification of this method. X-rays, like light waves, may be reflected from a crystalline surface, but unlike light waves the reflection occurs at atomic planes within the crystal and the reflected radiation at the superficial atoms is negligible. The equation upon which the measurement of wave lengths is based is:

$$n\lambda = 2d \sin \theta$$

where n is the order of the spectrum, d is the distance between the atomic planes and θ is the angle between the direction of incident radiation and the surface of the crystal.

Of the many forms of spectometers which have been devised, one of two is mostly used in medical radiology. Both of these are dependent on Bragg's method. That of Seeman depends upon photographic measurements and that of Staunig upon visual perception by means of fluorescence.

To obtain still further and more precise information, a photometric investigation of the lines should be made. This method, however, while it should lead to considerable improvement in precision of measurement, is not found in general practice.

Usually one of the following methods is used: (1) The indirect value of the absorption is determined by the photographic or fluorescent effects after the

passage of the rays through various graduated thicknesses of metal. These instruments have considerable practical value but they suffer from inaccuracies, due to selective absorption of the metals of the scales and the metallic salts of the photographic emulsion. Further, the time of exposure affects the results.

(2) Measurement of equivalent spark gap. The method is greatly used and depends upon the fact that the wave-length emitted by the tube is dependent upon the applied voltage, and this may be approximately measured by the equivalent spark gap. So many factors enter into this method that the results can only be regarded as roughly approximate.

(3) Perhaps the best practical method of measuring the average quality of the penetration of X-rays is by means of measurements of intensity before and after their passage through a given depth of absorbent material such as water or wax. Since the amount of absorption which corresponds to the decrease of intensity increases as the penetration decreases, the diminution of intensity is a measure of the average quality of the radiation. This method is perhaps quite practical, but again it suffers from inaccuracies in the measurement of intensity and sources of error are due to variations in scattering and of absorption with wave length.

Measurement of Intensity of X-rays

Ever since Roentgen rays were discovered there has been dissatisfaction with the methods that have been employed for measuring their intensity. The radiation intensity is a measure of quantity and may be defined as that radiation energy which strikes in one second upon a surface of 1. sq. cm. placed perpendicular to the direction of the ray. An absolute measurement of intensity for X-rays is very difficult and depends upon the very minute increase in temperature resulting in the complete absorption of the rays in an irradiated object. The method is, perhaps, only suitable to the physical laboratory and not for medical purposes unless improvements in micro-thermocouples render it practicable in the near future.

Chemical or structural changes have been greatly used in the past and various intensitometers based upon the accompanying changes in colour have been used. Errors, however, arise due to the colormetric method of estimation and selective absorption of the waves of X-rays by the material of the intensitometer. Another type of intensitometer is based upon the effect of X-rays on photographic plates. This is also subject to similar error, but owing to the intense effect on the plates the errors in general are less marked.

A common method is that dependent upon the change in colour of barium platino-cyanide. But here, besides errors in colour matching, heat and selective absorption cause errors and the method, while of use in therapy with small dosage, is of little use in deep therapy, where large doses calling for special skill have been applied. Fortunately, the errors are all on the side of under-dosage and this renders the method safe in the hands of those unskilled in therapeutic work.

The change in resistance of selenium when exposed to X-rays has been greatly used due to its convenience and in spite of inaccuracies due to selective absorption and fatigue. The method, while not rigidly accurate, is superior to the pastille method, and the quality as well as the intensity may be ascertained rapidly by comparative measurements of intensity above and below a given depth of water.

The actual reddening of the skin, called erythema reaction, is often used as a biological standard of dosage. This is unfortunate, since owing to variation

in skin manifestations, the reaction of the human skin cannot be used as a standard for comparison of physical factors. The reaction, moreover, of pathological tissues to radiation cannot be determined on the basis of the reaction of normal skin.

If conclusions are to be drawn as to the biological effects of radiation, measurements of the applied intensity and quality must be made accurately as possible in terms of physical units, even when an auxiliary biological method is also used. Moreover, it would provide a common ground for the intelligent recording of methods and results. It was this belief and the dissatisfaction with old methods that led to the method of measurement which is at present recognized as the most satisfactory.

The physical unit of radiation intensity as based on the property of X-rays known as the ionization of gases and the resultant electrical effect of this ionization is measured as a current in terms of the universally accepted electrostatic unit. The apparatus is now called "the air ionization chamber" and the current produced is measured by means of a galvanometer or electrometer or by means of an insensitive instrument combined with a valve amplifier. Experimental researches, using the ionization method of measuring intensity, proved so satisfactory that, at the Second International Congress of Radiology at Stockholm in 1928, the measurement of air ionization was accepted as the basis of international dosage measurement. It was agreed that the unit of X-ray dose should be called "the Roentgen" and be designated by the small letter r. The definition for this unit is:

> "The International unit is the quantity of X radiation which, when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in one cubic centimeter of atmospheric air at O° C. and 76 cm. of mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current."

Since then, many investigators have studied the problem of devising equipment which will unambiguously measure an X-ray beam according to the above definition and many important features overlooked by earlier investigators have been indicated. At the same time, there has been set up in the National Laboratories of Great Britain, Germany and the United States of America, open-air ionization chambers in terms of which dosage meters used in the particular country may be calibrated by comparison with the standard. Other countries, not having centralized standardization laboratories, have designated private and state institutions as custodians of their standard.

Again, at the International Congress of Radiology held in Paris in July, 1931, it was agreed that the international unit of quantity of radiation that had been formally adopted at Stockholm had, in general, proved satisfactory. Demands for a unit of intensity were met by a new recommendation to express intensity in r per minute or r per second. In order to further study of the method and technique and also to realize experimentally the specification of the r unit, a committee was appointed to co-operate with the several National Laboratories. The international X-ray Unit Committee, which dealt with all these matters, was constituted of a physicist and a physician from each of twenty different countries.

Radium

Closely following upon Roentgen's discovery of X-rays, M. Henri Becquerel at Paris, investigating the field of phosphorescent light, discovered in 1896 that the element uranium emitted rays capable of traversing material objects.

Thereupon, M. and Madame Curie proceeded to analyze the characteristics of uranium, and they found that the rays emitted were due, not to phosphorescent action, but to the disintegration of the uranium atom and that, in the process of disintegration, uranium produced a new element which Madame Curie separated and called radium.

The discovery was presented to the world in a joint paper by M. and Madame Curie and G. Bémont to the Academy of Sciences at Paris in 1898.

The subject of radio-activity was investigated and the theory of ionization of gases developed in 1899 by Wilson, Thomson, Rutherford and Townsend. In 1900 the three types of rays emitted by radium were separated and studied. In 1902 Rutherford and Soddy put forward their well-known atomic disintegration theory. According to this theory the atoms of a radio-active substance are undergoing a process of spontaneous disintegration, giving rise to the formation of a new atom, distinct in physical and chemical properties, from its parent.

Nature of Radium

Radium is a rare radio-active chemical element (Ra) belonging to the group of alkali earth metals which comprises the elements barium, strontium, calcium and magnesium. As a disintegration product of uranium, radium is never found in a natural state apart from its parent element. They always occur together geologically in a definite ratio of one part of radium to each 3,400,000 parts of uranium. Uranium has been found to exist in a number of different ores, such as pitchblende, carnotite and uraninite.

The atomic weight of radium is 226. Its chemical behaviour is identical with that of barium, forming a series of analogous salts (bromide, fluoride, sulphate, etc.). In its metallic state radium is a pure white metal but it is never used in that form because it changes quickly when exposed to air and reacts with water, decomposing it into hydrogen and oxygen with the production of radium hydroxide; hence, it is always prepared and used for therapeutic purposes in the form of radium salts. The processes involved in the extraction and purification of radium are both intricate and time-consuming and therefore costly. Usually, the final product in the purification is radium bromide.

Radio-activity

There are a number of radio-active elements, of which the most important are uranium, radium, polonium, actinium, thorium and mesothorium. Of these, radium is by far the most important because it disintegrates at a convenient rate, permitting the use of its radiation over a very long period of time, whereas all other radio-active substances disintegrate so much faster or slower that they are therefore correspondingly less valuable.

Radio-activity may be defined as the spontaneous emission from the nucleus of a complex atom of helium nuclei (alpha rays) or single negative electrons and gamma rays with the production of new forms of chemical matter. It is the outward evidence of spontaneous disintegration of the radio-active substance or transmutation of the element, atom by atom, into other substances. Until the discovery of radio-activity such atomic changes had not actually been observed. It is now well established that the process of disintegration is a dynamical one and always goes on at a perfectly definite and unalterable rate.

In the case of radium one per cent. of its mass disintegrates each twenty-five years, therefore the radio-activity of a pure radium preparation continues uninterruptedly for an average life period of 2,500 years—one-half of its atoms

disintegrating in a period of 1,690 years. Lead of atomic weight, 206, is a final end product, there being at least seven intermediate bodies intervening between radium and lead. They are radium emanation, radium A, radium B, radium C, radium D, radium E and radium F. Each of the above substances is formed from the one preceding it, after the manner of a cascade, with an outburst of energy evidenced by the emission of rays. The state of matter of the disintegration products is as follows: radium is a solid, radium emanation is a gas, radium A, radium B and radium C are solids.

Radium Rays

A purified radium preparation enclosed in a container will have produced within a period of thirty days of its enclosure an equilibrium quantity of emanation, radium A, B, and C, which will remain unvariable. Such a preparation simultaneously emits three distinct types of rays, designated by the terms alpha, beta, and gamma. As these rays differ from each other in character and in the rate at which they are discharged they produce different effects and are of different values therapeutically. Beta particles and gamma rays are not given off from the radium atom until disintegration has proceeded to radium C. Since beta particles and gamma rays are the ones used in radiation therapy it is really radium C, and not radium, that produces the therapeutic rays.

Alpha rays are positively charged particles; they are helium nuclei shot out from the nucleus of the parent atom at approximately 12,000 to 18,000 miles per second. These rays are completely absorbed by three inches of ordinary air or by excessively thin screens of any material such as a sheet of paper; they are consequently practically useless for extensive therapeutic application.

Beta rays are single negative electrons shot out from the nucleus of the parent atom at a velocity varying from 60,000 to 180,000 miles per second. Hard beta rays are one-half absorbed in one millimetre of soft tissue; one millimetre of lead or four millimetres of aluminium will completely absorb them.

Gamma rays are unlike the alpha and beta rays inasmuch as the latter are corpuscles or material particles while the former are electro-magnetic disturbances akin to X-rays, but of considerably shorter wave lengths. There are radioactive substances which emit gamma rays which have the same wave length as the X-rays actuated under high voltage, and in this case the two radiations cannot be distinguished one from the other. Gamma rays travel at the rate of 186,000 miles per second and penetrate six to eight inches of soft tissue; they are almost completely absorbed by five and one-half inches of lead. Owing to their great penetrating power gamma rays are generally recognized as the type of most therapeutic value. The beta rays as a class are approximately one hundred times more penetrating than the alpha and the gamma rays one hundred times more penetrating than the beta. According to their power of penetration they are called soft and hard beta and gamma rays. By methods analogous to those initiated by Laue in his investigations upon the wave lengths of X-rays, Rutherford and Andrade have measured the wave lengths of the more penetrating gamma rays emitted by radium B and radium C. Previous observation had shown that this radiation was heterogeneous, and the gamma rays which we speak of as being very penetrating consist of rays varying considerably in their wave lengths.

Each of these types of rays when passing through or striking material bodies set up secondary radiation; thus the alpha rays by concussion produce very feeble secondary beta radiation sometimes termed delta rays; the beta

rays—secondary gamma radiation; the gamma rays—secondary beta radiation; these secondary beta rays are of therapeutic value when produced within the tissues.

Quantitative measurements and standards. The unit of measurement for radium is the milligramme—one gramme equals one thousand milligrammes, also one gramme equals 15,432 grains, and 28.35 grammes equals one ounce avoirdupois. The quantitative value of a radium preparation is guaged by its degree of radio-active intensity. This radio-activity is measured by means of the electroscope in comparison with official standard tubes of known quantity. The primary standard is a glass tube containing 21.99 milligrammes of pure radium chloride prepared by Madame Curie which was adopted by the International Radium Standards Committee in March 1912, as the International Radium Standard. It is now kept at the Bureau Internationale des Poids et Mesures at Sèvres and is not used for practical work. Standard tubes certified by the International Committee, after comparison with the International Standard, are held in the national standardizing laboratories of the various countries. All radium preparations are now sold on the basis of a certificate of measurement issued by one of these institutions after comparison with a certified standard tube. In addition to the certificate of measurement, a guarantee of its purity of preparation and its freedom from mesothorium or other radio-active substance is given. In a reliable radium preparation, free from mesothorium, there may be a small degree of impurity due to barium; since measurements are made on the basis of radium element content the presence of a small amount of barium has no influence on the value of the preparation. If, however, there is an appreciable amount of barium it will absorb some of the radiation and measurements will indicate a smaller quantity of radium element than is actually present. On the other hand, if the impurity consists of mesothorium the value of the preparation is much affected. Thorium and its derivative mesothorium, although similarly radio-active, have a much shorter life than radium and are therefore of much less value. Mesothorium gives off beta and gamma rays, but it has a half life period of only five and one-half years while that of radium is 1,690 years.

Radium Emanation

As previously stated, the radio-activity of radium is due to the spontaneous disintegration of the radium atom. Just as radium is a disintegration product of uranium, so radium in its process of decay, forms a series of subsidiary substances, the first of which is known as radium emanation or radon. Radium emanation is a gas possessing the property of radio-activity. From the time of sealing up emanation is being constantly formed in the radium salt in proportion to the weight of radium present. Half the emanation produced during each unit of time is disintegrated after 3.85 days. The weight of radium remains exactly the same and there being a definite ratio between the quantities of emanation destroyed and produced, there comes a time when the decay balances the production and the quantity of emanation remains constant. This point is reached about thirty days after the sealing of the preparation and the radium is then said to be in equilibrium with its disintegration products. Emanation is supplied for therapeutic purposes in much the same way as radium salt, but as a comparatively large amount of radium element (one gramme or more) is needed to produce emanation in quantity, this method of treatment is not usually employed except by large institutions or private practitioners able to obtain a supply of emanation therefrom. The emanation is obtained from a solution of radium salt (usually radium bromide), and is drawn off into glass tubes by

means of special apparatus. Emanation is a comparatively short-lived gas; its growth and decay proceed at a precisely even rate, both processes being completed in a cycle of thirty days. During the first twenty-four hours after purification and separation the emanation loses practically sixteen per cent. of its radio-activity; in 3.85 days it loses one-half, and in 8.8 days four-fifths and so on. Standard tables for the decay and growth of radium emanation are available. As the rate of decay and growth are constant and invariable, the exact strength of any tube of emanation may at any time during its active period be instantly calculated from tables without the necessity of electroscopic measurement, provided both original strength and time of separation are known.

Unit of Measurement

The millicurie is the practical unit of emanation measurement, that is, one-thousandth part of a curie. A curie is the quantity of emanation in equilibrium with one gramme of radium element, namely, .6 cubic millimetres at 0 degrees C and a pressure of 760 mm. of mercury. One millicurie of emanation possesses, therefore, radio-active intensity equivalent to that of one milligramme of radium element. The millicurie is subdivided into the microcurie, which is the thousandth part of the millicurie and the millimicrocurie the thousandth part of the microcurie. One gramme of radium element in solution should generate daily about 164 millicuries of emanation of which, after allowing for losses and disintegration, 150 should be purified and collected. This daily output is constant and invariable from the time the radium reaches the point of equilibrium with its decay products.

Advantages and Disadvantages of the Use of Radon

Advantages: (1) Security. There is little danger of loss through accident, fire or theft as the radium is kept in a safe and the emanation drawn therefrom by means of a tube passing through the safe wall. (2) Capillary glass tubes containing the emanation have small monetary value.

Disadvantages. (1) The efficient collection and purification of emanation necessitate an intimate knowledge of radium physics and the emanation apparatus cannot be successfully worked except by a skilled technician. (2) Since modern technique may call for lengthy applications the rapid disintegration of the emanation offers a serious objection to its use inasmuch as the resulting radiation is not constant in intensity.

Radium Salts.

Radium for therapeutic application is generally used in the form of radium bromide or radium sulphate. Radium bromide is recommended only when a soluble salt is required (for use in an emanation apparatus, for instance). For enclosure in containers sulphate is usually used for the following reasons: (*a*) its high radium element content, which means the reduction of the containers to a minimum size. (*b*) its insolubility which offers a higher degree of security against loss and enhances the chances of recovery if it accidentally becomes mixed with other substances. Unfortunately, in past years the term radium was often used to mean one or other of the salts; as the salts vary in radium element content this practice detracted from the value of early work of investigation because it was often impossible to know what form of radium preparation and, therefore, what quantity of element had been employed. Properly, the term radium has never meant anything else but the element

itself, and it is in this accepted sense that the word radium should be used. It is the actual radium element content which determines the strength and value of a preparation of radium salts; it is, therefore, a matter of first importance that such element content should be known. For instance, instead of saying fifty milligrammes of hydrous radium bromide it saves confusion to say 26.79 milligrammes of radium element in the form of hydrous radium bromide. The radium element content per milligramme of radium may be readily ascertained by reference to a table of equivalent values.

Active Deposits

Alpha, beta and gamma rays are emitted by radium A, B, C, and D, which are the active deposits of emanation. It is possible to collect these deposits upon a sheet of metal and use them in place of radium or emanation, but it is considered impracticable because the life of such deposits is even shorter than that of emanation.

Dosage, Present Methods

There are several methods used of calculating dosage. A large majority of radiologists in the United States express the dose of radium or radium emanation as a certain number of milligramme hours or millicurie hours obtained by multiplying the quantity of radium or radium emanation by the time. A milligramme hour is the amount of radiation given off by one milligramme of radium element during one hour. If a definite number of milligramme hours is to be administered in a given case the use of a small quantity of the element must prolong the time of application, while the use of a large quantity will necessitate a much shorter duration of the exposure.

One millicurie is the quantity of emanation in equilibrium with one milligramme of element. It is evident that a preparation containing ten milligrammes of radium element applied during one hour will provide an intensity of ten millicurie hours corresponding to ten milligramme hours.

In Europe, radiologists often employ the term "millicuries destroyed." The reason for this terminology is that radium emanation has a large decay value, for instance, one millicurie of radium emanation at the end of twenty-four hours represents the strength of .8416 milligrammes of radium, so that in comparing a dosage a certain number of millcuries of radium emanation as against the same number of milligrammes of radium one must use an emanation decay chart based on known hourly decay periods of radium emanation. One must take into consideration the intensity at the beginning of a treatment and use a chart to find out the dosage.

When stating the quantity of millicuries destroyed this term indicates the quantity of emanation which is produced and destroyed in the unit of time (one hour) while, when stating the intensity in "millicurie hours," a constant quantity of emanation in equilibrium with the radium is indicated.

One of the most interesting problems associated with the physics of radium therapy is the distribution of radiation intensity around a radio-active source either in air or some denser medium such as water, wax or human tissues. We are almost ignorant of the intensity of a radiation at a given point in a growth into which the commonly used type of needle has been buried, and precise data are urgently required if the methods are to be rescued from empiricism. The methods already described for estimating dosages in milligramme hours or millicuries destroyed are not satisfactory. The state of affairs appears to be analogous to the position with respect to X-ray dosage

a few years ago, when the dose was defined in terms of conditions, such as kilovolts, milliamperes, filters, etc., circumstances relating to the source and not to the energy absorbed per cc. of tissue. The gamma ray problem is almost exactly that of the X-ray problem; it is more complex because of our smaller knowledge of the radiations concerned and the extremely rapid variation of intensity from place to place in the tissues. The ideal method of measuring dose should enable us to express the energy absorbed per cc. at any point throughout the mass irradiated. It should, moreover, be intimately related to the fundamental C. G. S. system of units and should not depend on the conditions of an experimental set-up. Two units might be suggested. (1) The fundamental C. G. S. unit of dose, namely, erg. per cc. of tissue. (2) An ionization unit, preferably the r unit as now used for X-ray dosage. It might appear that the first is preferable but there are difficulties in constructing apparatus to measure directly the small amounts of energy involved. It would seem advisable to choose an ionization unit, rather than use a derived one obtained by multiplication of an ionization current by one or more known factors. The r unit adopted for international use has now established itself in X-ray practice and it would be a very great convenience if X-ray and gamma ray doses could be expressed in the same unit, enabling us to compare the therapeutic effects of the same dose of different wave-length radiations.

This advantage is likely to gain weight with time since modern developments of both radium and X-ray therapeutic technique are tending to make the two methods of treatment more and more essentially one; from the radium side by the increasing use of external radiation as opposed to interstitial radiation, while technical progress in the X-ray field is placing at our disposal apparatus capable of the production of radiations which we may legitimately call artificial gamma rays.

X-ray and Radium Protection

The pathological effects of X-rays upon operators and patients were first noticed in 1896. But it was not until 1915 that recommendations for the greater protection of X-ray and radium workers were drawn up by the Roentgen Society of Great Britain. The X-ray Committee of the British War Office issued similar instructions late in the war. About 1921, several casualties from X-rays occurred, followed by a protest from the general public. The result was that the British X-ray and Radium Protection Committee came into being. Their recommendations were presented and formed the basis of the international protective recommendations adopted at the International Congress of Radiology held at Stockholm in 1928. An International Committee was also appointed.

Following this, advisory committees on X-ray and radium protection were set up in various countries to act in an advisory capacity. The International X-ray and Radium Protection Committee met in Paris on the occasion of the Third International Congress of Radiology. They agreed that a number of changes should be made in the light of experience and also by reason of the growth in the power of X-ray equipment. These alterations to the International Protection Recommendations were subsequently endorsed by the Congress.

A complete revised statement of the International Recommendations for X-ray and radium protection is set out below.

INTERNATIONAL RECOMMENDATIONS FOR X-RAY AND RADIUM PROTECTION

(Adopted at the Third International Congress of Radiology, Paris, July 1931)

1. The dangers of over-exposure to X-rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of X-ray and radium departments to ensure such conditions for their personnel. The known effects to be guarded against are:

(*a*) Injuries to the superficial tissues.

(*b*) Derangements of internal organs and changes in the blood.

2. The following working hours, etc., are recommended for whole-time X-ray and radium workers.

(*a*) Not more than seven working hours a day.

(*b*) Not more than five working days a week; the off-days to be spent as much as possible out-of-doors.

(*c*) Not less than four weeks holidays a year, preferably consecutively.

(*d*) Whole-time workers in hospital X-ray and radium departments should not be called upon for other hospital service.

(*e*) X-ray and particularly Radium workers should be systematically submitted both on entry and subsequently at least twice a year to expert medical, general and blood examinations. These examinations will determine the acceptance, refusal and limitation or termination of such occupation.

3. X-ray departments should not be situated below ground floor level.

4. All rooms, including dark rooms should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible.

5. All rooms should be provided with adequate exhaust ventilation capable of renewing the air of the room not less than 10 times an hour. Air inlets and outlets should be arranged to afford cross-wise ventilation of the room.

6. All rooms should preferably be decorated in light colours.

7. A working temperature of about 18 degrees C. (65 degrees F.) is desirable in X-ray rooms.

8. X-ray rooms should be large enough to permit a convenient layout of the equipment. A minimum floor area of 250 square feet (twenty-five square metres) is recommended for X-ray rooms and 100 square feet (ten square metres) for dark rooms. Ceilings should be not less than eleven feet (three and one-half metres) high.

9. Wherever practicable, the X-ray generating apparatus should be placed in a separate room from the X-ray tube.

10. An X-ray operator should on no account expose himself unnecessarily to a direct beam of X-rays.

11. An operator should place himself as remote as practicable from the X-ray tube.

12. The X-ray tube should be surrounded as completely as possible with protective material of adequate lead equivalent.

13. The following lead equivalents are recommended under average conditions.

	X-rays Generated by Peak Voltages	Minimum Equivalent Thickness of Lead
Not exceeding	75 k.v.	1 mm.
" "	100	1.5
" "	125	2
" "	150	2.5
" "	175	3
" "	200	4
" "	250	6
" "	300	9
" "	350	12
" "	400	15

14. In the case of diagnostic work, the operator should be afforded protection from scattered rays by a screen of a minimum lead equivalent of one mm.

15. In the case of X-ray treatment the operator is best stationed completely outside the X-ray room behind a protective wall of a minimum lead equivalent of two mm. This figure should be correspondingly increased if the protective value of the X-ray tube enclosure falls short of the values given in paragraph 13. In such event the remaining walls, floor and ceiling may also be required to provide supplementary protection for adjacent occupants to an extent depending on the circumstances.

16. Screening examinations should be conducted as rapidly as possible with minimum intensities and apertures. Palpation with the hand should be reduced to a minimum.

17. The lead glass of fluorescent screens should have the protective values recommended in paragraph 13.

18. In the case of screening stands the fluorescent screen should, if necessary, be provided with a protective "surround" so that adequate protection against direct radiation is afforded for all positions of the screen and diaphragm.

19. Screening stands and couches should provide adequate arrangements for protecting the operator against scattered radiation from the patient.

20. Inspection windows in screens and walls should have protective lead values equivalent to that of the surrounding screen or wall.

21. Efficient safeguards should be adopted to avoid the omission of a metal filter in X-ray treatment.

22. Protective gloves, which should be suitably lined with fabric or other material, should have a protective value not less than one-third mm. lead throughout both back and front (including fingers and wrist). Protective aprons should have a minimum lead value of one-half mm.

23. The floor-covering of the X-ray room should be of insulating material such as wood, rubber or linoleum.

24. Overhead conductors should be not less than nine feet (three metres) from the floor. They should consist of stout tubing or other coronaless type of conductor. The associated connecting leads should be of coronaless wire kept taut by suitable rheophores.

25. Wherever possible earthed guards, or earthed sheaths, should be provided to shield the more adjacent parts of the high-tension system. The use of X-ray equipment, having the high-tension current completely enclosed in earthed conductors is specially recommended. Unless there are reasons to the contrary, metal parts of the apparatus and room should be efficiently earthed.

26. Special electrical precautions should be taken in rooms where anesthetics are used in conjunction with X-rays.

27. The use of quick-acting double-pole circuit breakers is recommended. Over-powered fuses should not be used. If more than one apparatus is operated from a common generator, suitable overhead multi-way switches should be provided.

28. Some suitable form of kilovoltmeter should be provided to afford a measure of the voltage operating the X-ray tube.

29. The use of non-inflammable X-ray films should be encouraged. In the case of inflammable films suitable precautions should be taken as regards their use and storage. Large stocks should be kept in isolated stores, preferably in a separate building or on the roof.

30. (A) *Radium Salts.* Protection for radium workers is required from the effects of (a) Beta rays upon the hands. (b) Gamma rays upon the internal organs, vascular and reproductive systems.

31. In order to protect the hands from beta rays reliance should be placed in the first place on distance. The radium should be manipulated with long-handled forceps and should be carried from place to place in long-handled boxes, lined on all sides with at least 1 centimetre of lead. All manipulations should be carried out as rapidly as possible.

32. Radium, when not in use, should be stored in a safe as distant as possible from the personnel. It is recommended that radium tubes or applicators be inserted into separate lead blocks in the safe, giving a thickness of protective wall amounting to the value given in the following table:

Maximum Quantity of Radium Element	Thickness of Lead
0.2 gm.	8.5 cm.
0.5	10.0
1.0	11.5
2.0	13
5.0	15
10.0	17

33. A separate room should be provided for the "make-up" of screened tubes and applicators, and this room should only be occupied during such work.

34. In order to protect the body from the penetrating gamma rays during handling of the radium a screen of not less than 2.5 cm. thickness of lead should be used, and proximity to the radium should only occur during actual work and for as short a time as possible.

35. The measurement room should be a separate room and it should preferably contain the radium only during its actual measurement.

36. Nurses and attendants should not remain in the same room as patients undergoing radium treatment with quantities exceeding one-half gm.

37. All unskilled work or work which can be learnt in a short period of time should preferably be carried out by temporary workers, who should be engaged on such work for periods not exceeding six months. This applies especially to nurses and those engaged in "making up" applicators.

38. Discretion should be excercised in transmitting radium salts by post. In the case of small quantities it is recommended that the container should be lined throughout with lead not less than three mm. thick. It is more satisfactory to transport large quantities by hand in a suitably designed carrying case.

39. (B) *Radium Emanation.* In the manipulation of emanation, protection against the beta and gamma rays has likewise to be provided.

40. The handling of emanation should be carried out as far as possible during its relatively inactive state.

41. The escape of emanation should be very carefully guarded against, and the room in which it is prepared should be provided with an exhaust fan.

42. Where emanation is likely to come into direct contact with the fingers thin rubber gloves should be worn to avoid contamination of the hands with active deposits. Otherwise the protective measures recommended for radium salts should be carried out.

43. The pumping room should preferably be contained in a separate building. The room should be provided with a connecting tube from the special room in which the radium is stored in solution. The radium in solution should be heavily screened to protect people working in adjacent rooms. This is preferably done by placing the radium in solution in a lead-lined box, the thickness of the lead recommended being according to the table in paragraph 30.

In conclusion, it may be stated that if the best results are to be obtained, either in the actual application of X-rays and radium or in research work in connexion with them, it can only be attained by the close co-operation of physicists and medical men or by a man thoroughly qualified in both physics and medicine. In this connexion it may be of interest to call attention to the statement of Dr. Louis B. Wilson, Director of the Mayo Foundation for Medical Education and Research, who makes the following statement in his first formal report.

"Encourage every prospective medical student, who, at any stage in his educational career, shows any evidence of capacity for research, to familiarize himself with the fundamental facts of physics, chemistry and biology."

Estimates of Radium Required

The amounts of radium necessary in any country for the adequate treatment of cancer are usually placed at two grammes for each million of population, or for each 1,000 deaths from cancer or two to two and one-half grammes for each twenty-five beds for cancer. If teleradium is used in the form of a bomb a larger quantity up to four or five grammes will be required.

Dr. G. E. Richards, Radiologist of the Toronto General Hospital, Toronto, assuming that an active treatment centre will be set up in each of the medical teaching centres in Ontario, gives the following estimates.

"Until more accurate figures are available as to the exact number of cancer patients occurring in each locality, the following estimate is believed to be one which would fairly meet the needs in the beginning.

Assuming that an active treatment centre would be set up in each of the medical teaching centres of Ontario, it would be necessary to establish:

(1) *An Emanation Plant.* A central emanation plant should be established sufficient to provide for the needs of all three of the active treatment centres. We believe half a gramme of radium in solution would be sufficient for this purpose. One gramme would certainly be adequate. We think, in the beginning, there would be a considerable surplus radon from a gramme in solution, and that there would be difficulty in utilizing fully the output of this quantity. It would be better to begin with half a gramme and add to this if necessary. Since all three of the centres are within easy reach of one another, a single central emanation plant would be sufficient. This, we believe, should be situated in connexion with the active treatment centre in Toronto. Amount of radium required—500 milligrammes.

(2) The active treatment centres in London and Kingston should be equipped with the following quantities of radium:

(*a*) *Uterine Cases.* A sufficient quantity of radium in the form of radium element to permit of the preparation of any of the applicators in use for the treatment of carcinoma of the uterus, and for this purpose, 150 milligrammes of radium is ample. It should, however, be available in a series of applicators of different shape and size, so as to be elastic. Radium required—150 milligrammes.

(*b*) *Breast Cases.* A supply of radium needles in the form of heavily filtered platinum or platinum and gold should be provided sufficient to treat one breast case per week. This would require sixty needles, a suggestion being twenty-five three-milligramme needles, and thirty-five two milligramme needles. Radium required—145 milligrammes.

(*c*) *Mouth Cases.* In the beginning, it is not probable that these clinics would actually treat one breast case per week, and some of the two-milligramme needles could be used for mouth cases. In addition, there would be required about fifteen milligramme needles. Radium required—15 milligrammes.

(*d*) *Surface Applications.* Radium should be provided sufficient to permit of dealing with any ordinary surface application necessary. This could be done by utilizing the radium provided for cervix cases when it is not in use for that purpose, at least until further experience is gained as to the number of cases coming for treatment. If an additional fifty milligrammes is provided for this purpose it would be adequate. Radium required—50 milligrammes.

(*e*) *Packs.* The fifty milligrammes provided for surface applications, together with the 150 milligrammes for cervix cases would be available for radium packs when it is free, thus giving a total quantity of 200 milligrammes which is a very adequate amount. Thus, in each of these centres, there would be required about 350 milligrammes or a total of 700 milligrammes for these two centres.

(3) *Toronto Centre.* In addition to the radium emanation plant, an additional gramme of radium should be provided in the form of radium element in various applicators, the details of which could be worked out later. In addition to this, the merits of a bomb containing from four to five grammes of radium, should be investigated and a comparison made between the relative effectiveness of such a bomb and of that obtainable from one of the very high-powered deep X-ray therapy units. A five-gramme bomb would cost two hundred and fifty thousand dollars at the outside. This is a question regarding which further information would be necessary. Radium required—one gramme. If a bomb is decided upon—five grammes additional.

Each of the active treatment centres should, in addition, be provided with complete installations, for the administration of deep X-ray therapy. With the exception of the new, very high-powered apparatus, these units cost about ten thousand dollars each. Together with other necessary accessories, fifteen thousand dollars for each centre might be estimated for this item."

SPECIFICATIONS FOR RADIUM

Active Treatment Centres:

Kingston London

Needles of platinum iridium, having a wall thickness of 0.5 mm. containing radium element in individual platinum cells as follows:

25	needles	each	containing	1 mg.	length	of	needles	27.7	mm.....	25 mg.
25	"	"	"	2 mg.	"	"	44	mm.....		50 mg.
25	"	"	"	3 mg.	"	"	60	mm.....		75 mg.
5	"	"	"	10 mg.	"	"	20	mm.....		50 mg.
										200 mg.

(Wall thickness—1 mm. lead)

20 needles monel metal each containing 10 mg., length 27.5 mm..... 200 mg.

Total..... 400 mg.

Value of radium for the two centres 800 mg. at $55.00..... $44,000 00

Value of Containers:

50	needles x	1 mg.	at	$12 50.....	$625 00
50	" x	2 mg.	at	17 75.....	877 50
50	" x	3 mg.	at	22 75.....	1,137 50
10	" x	10 mg.	at	18 50.....	185 00
10	" monel metal		at	12 50.....	250 00
					$3,075 00

Toronto

Platinum iridium needles having wall thickness of 0.5 mm. as follows:

25	needles each	containing	1 mg.	radium.....		25 mg.
50	" "	"	2 mg.	"	.....	100 mg.
50	" "	"	3 mg.	"	.....	150 mg.
5	" "	"	10 mg.	"	.....	50 mg.
						325 mg.

Platinum iridium needles having wall thickness of 0.8 mm. as follows:

50	needles each	containing	2 mg.	radium.....		100 mg.
50	" "	"	3 mg.	"	.....	150 mg.
						250 mg.

20 monel metal needles each containing 10 mg..... 200 mg.
(This for use as a pack, or for other similar purpose).

Total, Radium..... 775 mg.

Value of Containers:

25	needles x	1 mg.	at	$12 50.....	$312 50
50	" x	2 mg.	at	17 75.....	877 50
50	" x	3 mg.	at	22 75.....	1,137 50
20	monel metal needles x	10 mg.	at	12 50.....	250 00
10	needles x	10 mg.	at	18 50.....	185 00
					$2,762 50

50	needles x 0.8 mm. wall x	2 mg			$1,137 50
50	" x 0.8 mm. wall x	3 mg			1,250 00
					$2,387 50

(Above prices estimates, accurate prices not available).

Summary of Radium Required:

London, Radium Element	400 mg.
Kingston, " "	400 mg.
Toronto, " "	775 mg.
Toronto, " in Solution	425 mg.
Total	2,000 mg.

In the above estimate the radium element contained in monel metal needles is intended for use in certain types of cases such as making up tubes for treatment of cervical carcinoma in the uterus, and is also intended to be used to make up a pack, thus giving a 200-milligramme pack, which is a very excellent quantity for this purpose. These needles are also suitable for most of the simple surface applications, and in this form may be kept almost constantly in use.

Memorandum

Packing, shipping, insurance and Bureau of Standard's fee extra. These can only be estimated, but they amounted to practically $500.00 on a recent purchase of 500 milligrammes and this might be accepted as a fairly accurate estimate on each quantity of 500 milligrammes.

If, in addition to the above, it is considered desirable to keep a supply of radium in reserve, it would be necessary to purchase an additional 500 milligrammes. This might be made up as follows:

20 monel needles, 10 mg. each									200 mg.
50 needles, platinum iridium, 0.5 mm. wall each containing 2 mg.									100 mg.
25	"	"	"	0.8 mm.	"	"	"	2 mg.	50 mg.
25	"	"	"	0.5 mm.	"	"	"	3 mg.	75 mg.
25	"	"	"	0.8 mm.	"	"	"	3 mg.	75 mg.
									500 mg.

On the other hand it might be considered wiser to defer action of this sort until the entire scheme has been in operation for a year or more, and the needs of the work become more fully known.

(*Richards.*)

VARIETY OF TECHNIQUE

There is no unanimity of opinion as to the best method of application either of radium or X-ray. While the results everywhere were most encouraging, it was apparent that individual operators were using the method to which they were most accustomed and which experience justified. The general plans of using radium in the Canadian, United States and European clinics are as follows:

DIFFERENT METHODS OF TREATMENT WITH RADIUM

Clinic	Dose (mg. el.) Hours	Amount	Time	Time (Intervals)
Kehrer's Clinic (Dresden)	6,000 to 10,000	100 to 150	Not Stated	Three series with 2 to 3 days' intervals.
Radium Institute, Paris (Regaud).....	5,000 to 8,000 (40-60 mc. d)	60	6 days	Continuous.
Cancer Hospital (London)	4,800 to 9,200	240	20 to 30 hours	Sometimes repeated.
Howard Kelly Hospital, Baltimore, U.S.A.....	3,000 to 4,400	Up to 1,200	1 to 4 hours	One dose. Repeat if necessary after 2 or 3 months reducing does on 2nd occasion.
Mayo Clinic.....	4,000 to 9,000	50	14 hours	Eight to twelve applications at interval of 48 to 72 hours.
Memorial Hospital, New York (Baily & Healy)	2,000 to 5,000	50 uterus 100 vagina	48 hours	Two applications, interval 48 hours.
Radiumhemmet (Heyman & Forsell).....	6,800 to 7,600	105 to 112	22 hours	Three applications: 2nd 7 days after 1st. Third, 21 days after 2nd.
Toronto General Hospital	2,400 to 8,490	60 to 100	24 hours to 6 days	Repeat in 2-3 months, if necessary.

SPECIFICATIONS FOR RADIUM FOR MICHAEL REESE HOSPITAL, CHICAGO, ILLINOIS

24 Platinum-iridium needles, each enclosing end to end three platinum cells that contain 1.6 milligrammes each. Dimensions of needles: 60.0 mm. length, 1.65 mm. external diameter, of 0.4 mm. wall thickness. Dimensions of cells: 16.0 mm. length, 0.8 mm. external diameter, 0.1 mm. wall thickness. Combined wall thickness (needle and cell), 0.5 mm..... 115.2 mgms.

16 Platinum-iridium needles, each enclosing end to end three platinum cells that contain 1 milligramme each. Dimensions of needles: 44.0 mm. length, 1.65 mm. external diameter, 0.4 mm. wall thickness. Dimensions of cells: 10.0 mm. length, 0.8 mm. external diameter, 0.1 mm. wall thickness. Combined wall thickness (needle and cell), 0.5 mm..... 48.0 mgms.

16 Platinum-iridium needles, each enclosing end to end two platinum cells that contain 1 milligramme each. Dimensions of needles: 32.0 mm. length, 1.65 mm. external diameter, 0.4 mm. wall thickness. Dimensions of cells: 10.0 mm. length, 0.8 mm. external diameter, 0.1 mm. wall thickness. Combined wall thickness (needle and cell), 0.5 mm..... 32.0 mgms.

14 Platinum-iridium needles, each enclosing a single platinum cell of 1 milligramme. Dimensions of needles: 22.0 mm. length, 1.65 mm. external diameter, 0.4 mm. wall thickness. Dimensions of cells: 10.0 mm. length, 0.8 mm. external diameter, 0.1 mm. wall thickness. Combined wall thickness (needle and cell), 0.5 mm..... 14.0 mgms.

209.2 mgms.

All of the above described platinum-iridium needles are to be made with double eye and trocar point. Our laboratory, if found necessary, is to be allowed to increase length of needles by one or two millimeters to accommodate the double eye.

25 Platinum removable cells of 1 milligramme each. Dimensions of cells: 6.0 mm length, 1.0 mm. external diameter, 0.2 mm. wall thickness..... 25.0 mgms.

For use with these cells there are to be provided monel sheath needles of 0.3 mm. wall thickness, as follows:

12 needles having a length of 36.0 mm. to enclose four cells each.
10 needles having a length of 30.0 mm. to enclose three cells each.
10 needles having a length of 24.0 mm. to enclose two cells each.
10 needles having a length of 19.0 mm. to enclose one cell each.

All of the sheath needles described above are to have an external diameter of 1.65 mm. and to be made with double eye and removable trocar monel points.

Five Platinum-iridium tubes (bull-dog eye), 16.0 mm. long, 0.8 mm. wall thickness (plug screw-cap and eye), each to be of sufficient bore to hold five of the above-described cells in a bunch.

5 Monel metal needles of 5 milligrammes each. Dimensions: 14.5 mm. length, 1.25 mm. external diameter, 0.25 mm. wall thickness..... 25.0 mg.

Radium filled directly into needles—no cell. Needles are to be of standard design and to have single eye and conical point.

22 Platinum-iridium tubes (bull-dog eye), having a length of 21.7 mm., external diameter of 2.65 mm., wall thickness of 0.9 mm., each enclosing a single non-removable platinum cell of 5 milligrammes. Dimensions of cells: 16.0 mm. length, 0.8 mm. external diameter, 0.1 mm. wall thickness. Total wall thickness (tube and cell), 1.0 mm..... 110.0 mg.

The 22 platinum-iridium tubes of the 5 mgm. size are to be engraved with the figure "5."

1 Standard monel metal tube (without eyelet). Dimensions: length, 11.0 mm., external diameter, 2.0 mm., wall thickness, 0.25 mm..... 25.0 mg.

Radium to be filled directly into tube—no cell.

1 Full strength glazed plaque. Dimensions (glazed surface): 1.0 x 1.0 cm..... 5.0 mg.

Total..... 399.2 mg.

(*Cutler.*)

INDEX

Copies of the Pamphlets on Cancer named below may be had on application to the Department of Health, Parliament Buildings, Toronto, Ontario.

1. What Everyone Should Know about Cancer.
2. The Doctor and the Cancer Patient.
3. Cancer of the Mouth.
4. A Word to You about Cancer.
5. Important Facts for Women about Tumours.
6. The Prevention of Cancer.